REPORT

METROPOLITAN SEWERAGE COMMISSION

OF

NEW YORK

1912

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November 1912

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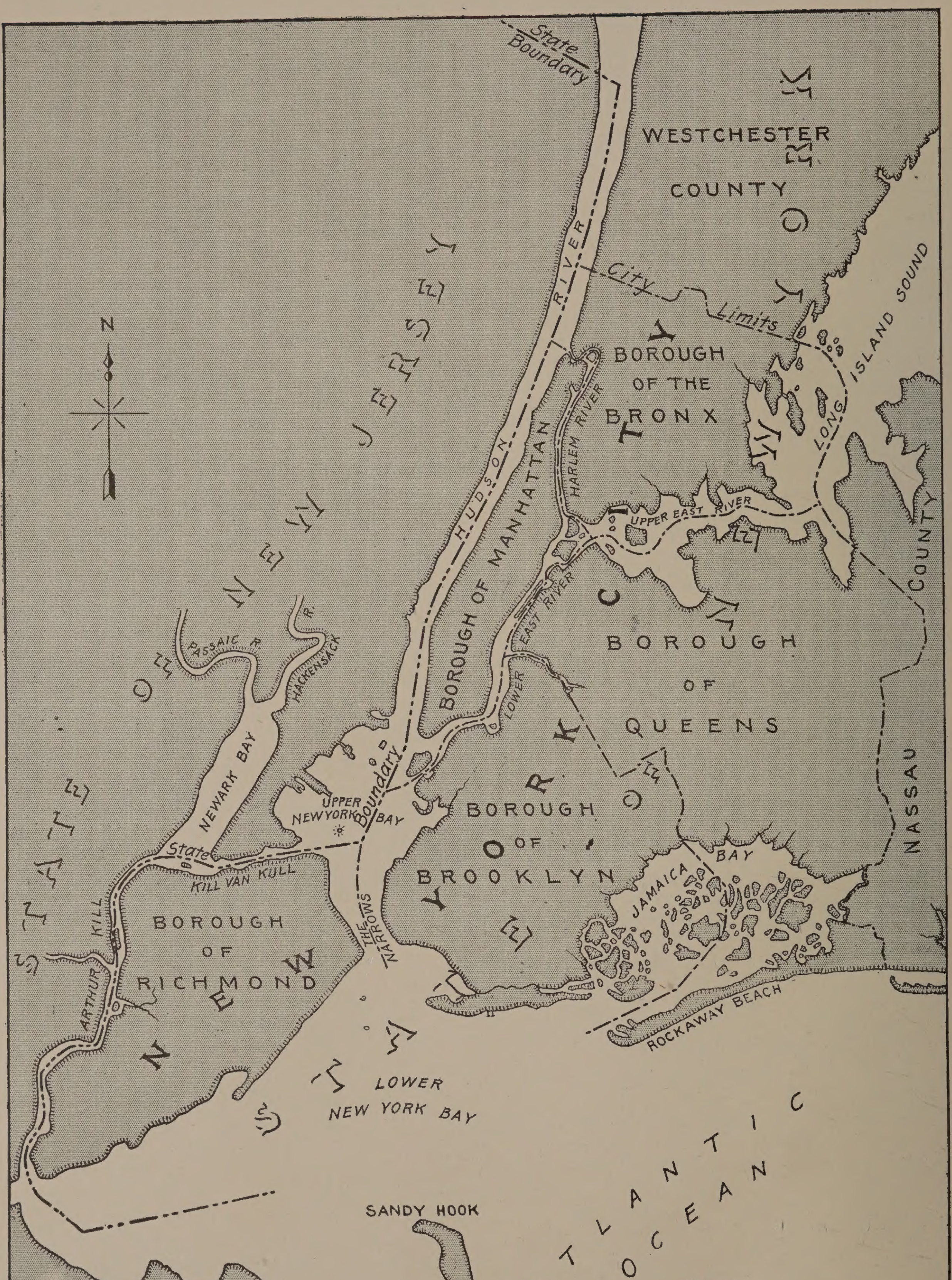

New York Harbor, Showing the Boundary between New York and New Jersey, and the Five Boroughs of New York City

PRESENT SANITARY CONDITION OF NEW YORK HARBOR AND THE DEGREE OF CLEANNESS WHICH IS NECESSARY AND SUFFICIENT FOR THE WATER

REPORT

OF THE

METROPOLITAN SEWERAGE COMMISSION OF NEW YORK

Appointed under Chapter 639, Laws of 1906, amended by Chapter 422, Laws of 1908
and by Chapter 200, Laws of 1910, of New York State

AUGUST 1, 1912

GEORGE A. SOPER, President
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LETTER OF TRANSMITTAL

New York, August 1, 1912.

Honorable William J. Gaynor, Mayor of the City of New York,
Executive Chamber, City Hall, New York City.

Sir: This report describes the sanitary condition of New York harbor in the years 1909 and 1911, as that condition was determinable, by means of analytical investigations, as well as by the unaided senses, and proposes a standard of cleanness for the waters.

Attention was first called to the polluted condition of the harbor in the reports of the New York Bay Pollution Commission, dated March 31, 1905, and April 30, 1906; further investigations of the quality of the water, and the causes which lead to its contamination, were reported on by the Metropolitan Sewerage Commission in its report of April 30, 1910. The present report brings the subject up to January 1, 1912.

In the year 1910, an investigation of the pollution of New York harbor was made by Col. Wm. M. Black, U. S. A., and Prof. Earle B. Phelps, at the request of the Board of Estimate and Apportionment of the City of New York, the outcome of which was a report, dated February 16, 1911, and published by the Board of Estimate and Apportionment on March 23, 1911. Basing their opinion on their studies, which covered a period of 15 months, the authors recommended that a chemical standard of purity be established for the harbor and considered that 70 per cent. of the saturation value of dissolved oxygen would be a proper standard to be maintained, if possible.

Upon the receipt of the report of Messrs. Black and Phelps, the Board of Estimate and Apportionment proposed to appoint a commission of five engineers, to consist of Colonel Black, the President of the Metropolitan Sewerage Commission and three other persons, to advise the board as to the percentage of saturation value of dissolved oxygen which the city should strive to maintain in the waters of the harbor. On June 9, 1911, the Metropolitan Sewerage Commission, which had already been making studies in this direction, offered to undertake such further investigations as were necessary and to advise the Board as to its conclusions. By resolution, adopted June 22, 1911, the Board of Estimate and Apportionment accepted this offer and placed the subject in the hands of this commission for report.

The degree of cleanness which should be maintained in the more frequented parts of New York harbor should, in the opinion of the Metropolitan Sewerage Commission and their consulting experts, depend as much upon the evidence of the senses as upon data collected by chemical and bacterial analysis. The standard of cleanness suitable for any part should also depend upon the uses to which the water in that locality is, or may reasonably be, put.

The investigations described in this report show that it will be necessary to make extensive improvements in the prevalent manner of disposing of New York's sewage, and that main drainage works will be necessary in order to divert the sewage from many of the present points of outfall. How to deal with the sewage after it has been collected to other and more suitable points depends upon the condition of cleanness in which the harbor waters should be kept. It is possible to purify the sewage to any desirable degree, but the cost depends largely upon the extent to which the impurities are removed.

In disposing of sewage into New York harbor, the possibility of creating unpleasant consequences in two principal respects should be kept carefully in mind: First, the possibility of creating local nuisances at the new points of outfall before the sewage becomes mixed with the water; and, second, the chance of overloading the digestive capacity of the water after admixture takes place, with the consequent production of a general nuisance. Local nuisances are almost always due to lack of prompt diffusion of the sewage through the water into which it is discharged. General nuisances are produced after the sewage has been thoroughly intermingled with the water.

The investigations made prior to May, 1910, on which the subject matter of this report is in part based, were discussed more in detail in the commission's report of April 30, 1910.

Respectfully submitted,
METROPOLITAN SEWERAGE COMMISSION OF NEW YORK,
GEORGE A. SOPER,
JAMES H. FUERTES,
H. DEB. PARSONS,
CHARLES SOOYSMITH,
LINSLY R. WILLIAMS.

FOREWORD

The following report, like its predecessor issued April 30, 1910, is in three parts.

Part I describes the sanitary condition of the harbor and discusses the question of its pollution in easily understood terms.

Part II gives the Commission's opinion and the opinions of various persons consulted by the Commission as to the degree of cleanness which should be considered necessary and sufficient for the water.

Part III contains tables and plottings of analytical data relating to the condition of the harbor.

An extensive table of contents and numerous page and sectional headings will facilitate reference to the various subjects contained in the report.

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PART I

Present Sanitary Condition of New York Harbor

PART I

Present Sanitary Condition of New York Harbor

CHAPTER I

GENERAL DESCRIPTION OF THE HARBOR

Main Divisions. New York harbor is situated in a re-entrant angle of the Atlantic coast line. It consists of ten main divisions, as follows:

1. Lower bay
2. Jamaica bay
3. Arthur Kill
4. Upper bay
5. Kill van Kull
6. Newark bay
7. Hudson river
8. Lower East river
9. Upper East river
10. Harlem river

Fig. 1 is a map of the harbor showing the main divisions.

The two largest divisions are the Lower and the Upper bays. The Upper bay is joined on the north by the Hudson and Lower East rivers and on the west by the Kill van Kull, which, in turn, is connected with Newark bay. The Arthur Kill joins Newark bay with the Lower bay by a narrow, winding channel. The Hudson and the East rivers are joined by the Harlem river. These three rivers, together with Upper New York bay, bound the Island of Manhattan. The Upper East river connects the Harlem and Lower East river with Long Island Sound. Jamaica bay is situated near the outer limits of the harbor.

Lower Bay. About one-half the total water surface of New York harbor lies between the Narrows and the sea. The ocean boundary extends from Sandy Hook to Rockaway Point. This large expanse of water is comparatively shallow. Ships moving in and out of the harbor pass through the Lower bay in channels artificially built and maintained.

Much of the shore line of the Lower bay is unoccupied, although extensive places of amusement and bathing beaches are located at points which are of comparatively easy access to the residence parts of the city. The cultivation of shellfish is an extensive industry in Lower New York bay.

Jamaica Bay. Jamaica bay is sheltered from the sea by a low-lying, sandy peninsula, which extends from the main body of Long Island in the direction of Sandy Hook and terminates at Rockaway Point. Jamaica bay is bordered on all but the ocean side by low-lying tidal meadows. Grassy islands, many of which are, like the mainland shores, flooded at spring tides, occupy a large part of the total area. About three-quarters of Jamaica bay is less than 6 feet in depth at low water. The waters of Jamaica bay are used for shellfish culture, boating, fishing and bathing. A large population exists on and about these shores in summer. A project is under way whereby the city of New York and the United States Government are to develop Jamaica bay for commercial purposes.

Arthur Kill. Arthur Kill is a narrow, winding tidal stream, about 13 miles long, which separates Staten Island from the mainland. A channel about 20 feet in depth traverses its whole length. Throughout most of its course, Arthur Kill is bordered by extensive tidal marshes. Except near its two ends, the shores are sparsely populated. A number of industrial establishments are located on its banks.

Upper Bay. Upper New York bay is connected with the Lower bay by a deep strait known as the Narrows, which lies between Brooklyn and Staten Island. About one-quarter of the Upper bay has a depth of 35 feet or more and about one-third is 12 feet deep or less.

Navigation in the Upper bay is chiefly confined to a broad, natural main channel which runs nearly through the middle of the bay. The east side of this channel shoals gradually; the west side is steep and bordered by a long stretch of shallow water extending to the shore line.

The shores of Upper New York bay are mostly occupied by piers, docks and other facilities for shipping. There are few residences near the water, although many in sight of it. Along the southwest shore of Brooklyn there is an extensive parkway. One of New York's most famous and most frequented parks, the Battery, is situated on the shore at the north end of the Upper bay. Three islands in the Upper bay, which are used for immigrant and military purposes, are owned by the United States Government.

The waters of Upper New York bay are used extensively for shipping. A few oysters are taken from natural beds in the vicinity of Robbins Reef, which lies near the center of the bay. Bathing is indulged in on the Brooklyn shore. Yachting is a favorite pastime.

Upper New York bay is the port's greatest highway for commerce. Ships pass through it on their way to and from the ocean and from one docking center to another.

Kill van Kull. The Kill van Kull is a strait about three miles long, connecting Newark bay with the Upper bay, and separating Bayonne on the north from Staten Island on the south. It is an important, navigable body of water of considerable depth. Oil refineries, ship-yards and numerous manufacturing establishments are located on its shores. Some of the most thickly settled portions of Staten Island lie along its south bank.

Newark Bay. Newark bay, which lies west of Upper New York bay, has about two-fifths as much area as the latter. The water is very shallow. More than half of the bay is less than 6 feet in depth, and about seven-eighths is less than 12 feet at low water. The deepest channel has been dredged so as to give a permissible draft of 12 feet for vessels to the City of Newark. At its north end it receives the flow of the Passaic and Hackensack rivers, and at the south end it is connected with the Upper and Lower bays by the Kill van Kull and Arthur Kill.

The shores of Newark bay are, for the most part, sparsely inhabited. There are some manufacturing plants and a few ship-yards, but there is little deep water shipping. Newark bay may be regarded as a commercial highway which connects a number of municipalities, of which Newark is the chief, with New York bay and its tributaries.

Hudson River. The Hudson is the largest river which enters New York harbor. The size of this stream, however, gives an exaggerated idea of the volume of water which it discharges. For 150 miles the river is tidal. Salt water flows up it at times for a distance of 50 miles or more.

There is a wider deep channel in the Hudson river than in any other part of New York harbor except the Upper bay. The docks on the New York shore can be utilized by ocean-going vessels of the deepest draft. About one-half of the Hudson river below Yonkers is 35 feet or more in depth.

The Hudson is used for purposes of transportation and for the docking of coastwise and trans-Atlantic vessels. Like other parts of the shores of New York harbor, the great railroad companies which enter New York make extensive use of the water-front for handling freight. About one-half of the New York City shore of the Lower Hudson is used for park purposes. In some localities residences, in others tall office buildings, crowd the water front. The New Jersey shore is partly developed for manufacturing, shipping and railroad uses.

Lower East River. The East river, which extends from the lower end of Manhattan Island to Long Island Sound at Throgs Neck, is, in reality, a strait. It is divisible into two parts of approximately equal length, the point of division being just east of its confluence with the Harlem river. The part which lies northeast of this point is here called the Upper East river and the part south of it the Lower East river.

The shores of the Lower East river are smooth and regular, having been made so largely by improvements to the water-fronts of Manhattan and Long Island. The water is deep and almost everywhere navigable to the shore lines for ocean-going vessels. The shores are closely built up and are largely occupied by wharves. In many cases freight is exchanged between ships and railroad cars which are brought alongside of the piers on barges. There are many large manufactories on both sides of the river.

Midway in its course, the Lower East river is joined by Newtown creek, a densely polluted tidal stream which winds through a manufacturing district on Long Island.

The Lower East river is essentially a commercial highway. It is, at the same time, much used for purposes of recreation and health, as may be seen from the presence of numerous recreation piers, hospitals and parks which are maintained at the city's expense. Floating bathing establishments, through which water from the harbor freely circulates, exist on both shores. Two large islands, between the Lower East river and the Harlem, and Blackwell's Island in the Lower East River, are occupied by charitable and penal institutions.

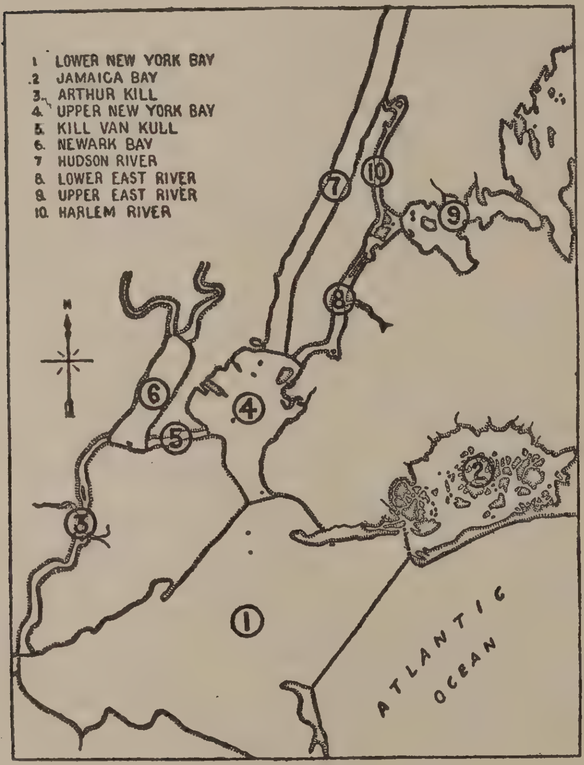

FIG. 1
Map of New York Harbor, Showing the Main Divisions

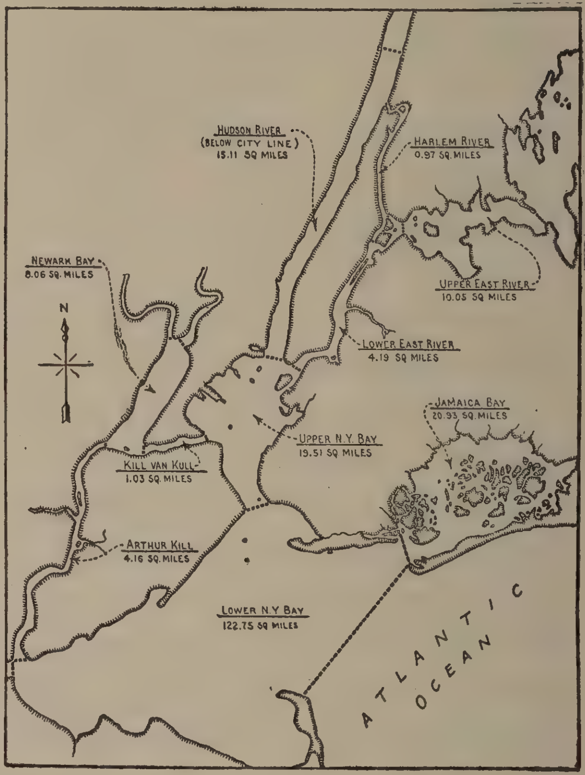
HUDSON RIVER (BELOW CITY LINE) 15.11 SQ MILES
HARLEM RIVER 0.97 SQ. MILES
NEWARK BAY 8.06 SQ. MILES
N
UPPER EAST RIVER 10.05 SQ MILES
LOWER EAST RIVER 4.19 SQ MILES
JAMAICA BAY 20.93 SQ. MILES
UPPER N.Y. BAY 19.51 SQ MILES
KILL VAN KULL 1.03 SQ. MILES
ARTHUR KILL 4.16 SQ. MILES
LOWER N.Y. BAY 122.75 SQ MILES
ATLANTIC OCEAN

FIG. 2
Areas of the Main Divisions of New York Harbor

Upper East River. The half of the East river which lies to the east of its confluence with the Harlem differs in many respects from the half which lies between the division line and the southern end of Manhattan. The shores of the Upper East river, instead of being smooth and parallel, like those of the Lower East river, are irregular and deeply indented with bays which are separated by prominent points of land.

Although the total water surface of the Upper East river is large, the volume of water in it is comparatively small, for the depths over much of its area are slight. A broad, deep channel runs between all the prominent headlands, but the bays are, for the most part, less than 6 feet in depth.

The Upper East river is used chiefly as a highway to and from the shipping centers of the inner harbor and Long Island Sound. The shores are partly occupied. There are factories in some places and in others some residential districts are situated close to the water. For the most part, the shores are in a transition stage of development. The land is no longer desirable for large country estates and has not yet been utilized for purposes of commerce and manufacture. At Clason Point and North Beach extensive summer recreation centers have been established by private enterprise. These points are fairly convenient of access from dense centers of population. Much of the amusement afforded is connected more or less with the water. Bathing and boating are among the most common pastimes.

Harlem River. The Harlem river, which extends from the Hudson to the East river, is a comparatively narrow, shallow, rapid-flowing stream. For about one-quarter of its course the Harlem is bordered by a parkway. The Harlem is used not only for purposes of transit, but as a center for recreation. The headquarters of most of the rowing clubs of New York are situated here.

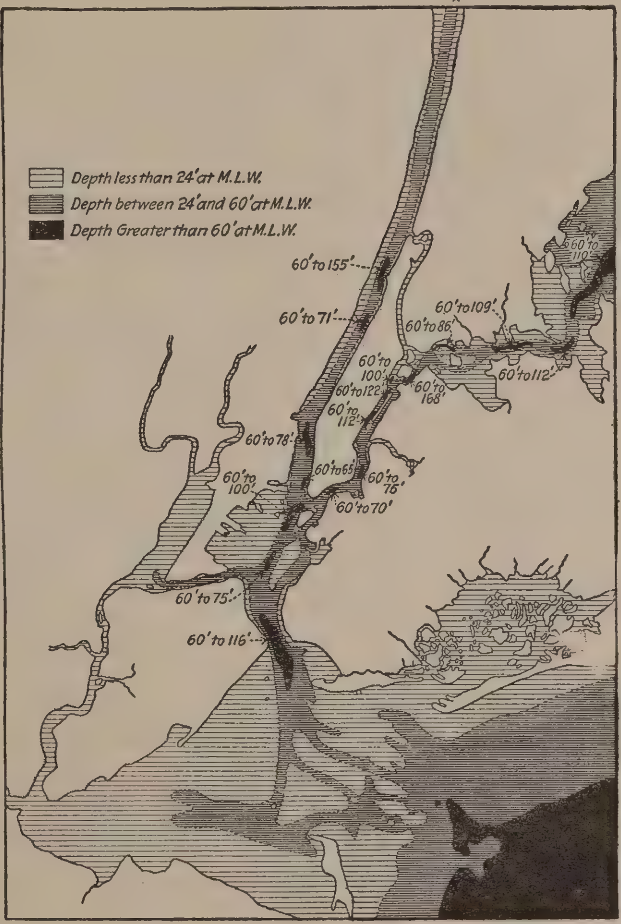

FIG. 3
Main Channels of New York Harbor

Area and Depth. The total water surface of New York harbor is about 210 sq. miles at high tide. The areas of each of the main divisions are shown on Fig. 2. Fig. 3 shows the comparatively small proportion of harbor occupied by the main channels.

CHAPTER II

VOLUME AND CIRCULATION OF THE WATER

Sources of Harbor Water. The water in New York harbor, practically all of which is available for the disposal of sewage, consists of the runoff from the natural drainage areas and the sea water which circulates in the harbor under the action of the tidal influences.

The Hudson river discharges much more water seaward at some seasons of year than at others. This discharge is least during the summer months when it is most needed. The action of the sea water as it flows in and out of the harbor is more constant than the discharge of the Hudson, but is susceptible of considerable variation because of wind and is less effective in some parts of the harbor than in others. The range of tide is not the same in all localities, and the times at which high and low water occur at different points vary considerably. These changing conditions produce marked irregularities in effect.

Quantities of Water. The United States Coast and Geodetic Survey and the Metropolitan Sewerage Commission have studied the quantities of water flowing at the Narrows, and at the mouths of the Hudson and East rivers; that is, where the Hudson and East rivers join Upper New York bay; but it seems unnecessary here to describe the researches which have been made into this subject.*

The volume of water discharged on each tidal current has been estimated in accordance with methods used for calculating the flow of rivers. The estimates are of necessity only approximately correct. They are based on the area of a selected cross section below the level of the water surface, the velocity of the current and the time during which the current flows. The basic data for these estimates were observations of levels, determinations of velocities attained by floats and surveys of cross sections.

For practical purposes, the quantity of water which ebbs and flows through the Narrows may be taken as 12,000,000,000 cu. ft. per tide. The excess of seaward-moving water over the water which returns is about 1,300,000,000 cu. ft. per tide. The water which comes down the Hudson from the land, in excess of the water which is carried back up the river by the tide, is 1,100,000,000 cu. ft. per tide. An excess of water which probably amounts to 100,000,000 cu. ft. per tide flows toward the sea from the tidal actions in the East river.

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*See Report Metropolitan Sewerage Commission of New York, April 30, 1910, pp. 149 to 215, incl.

It was once thought that the difference in range of tide and difference in time of high water, at the ocean and sound entrances of the harbor, caused a large amount of sea water to flow through the East river into Upper New York bay and thence to the ocean, as is the case with the Hudson. The studies made by the United States Coast and Geodetic Survey, and supplemented by the investigations of the Commission, do not substantiate this theory. It has been found that if a net discharge occurs it is so small as to be negligible from the standpoint of sewage disposal. Nearly as much water flows in one direction as in the other.

That there is more water flowing southward through the Hudson river than returns is due to the land water which is discharged from the drainage area of the river. At the Narrows, where the waters of the Upper bay and its tributaries discharge into the Lower bay, there is an excess of seaward-moving water. This excess is not far different from that of the Hudson river itself. Although the actual quantities of water moving in each direction under tidal influences are greater at the Narrows than at the mouth of the Hudson, the surplus which passes seaward at each point is nearly the same. The volumes of water in New York harbor are shown by Table I and graphically by Figs. 4 and 5.

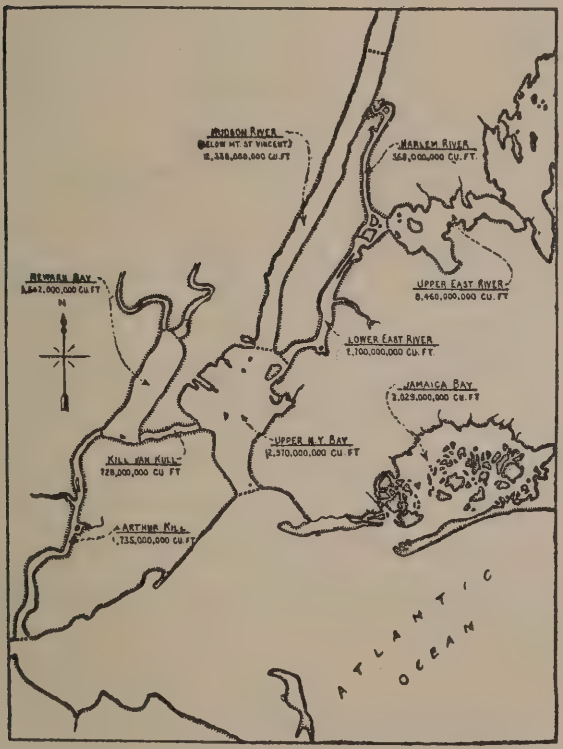

FIG. 4

Volumes of Water which Lie Beneath the Level of Mean Low Tide in New York Harbor

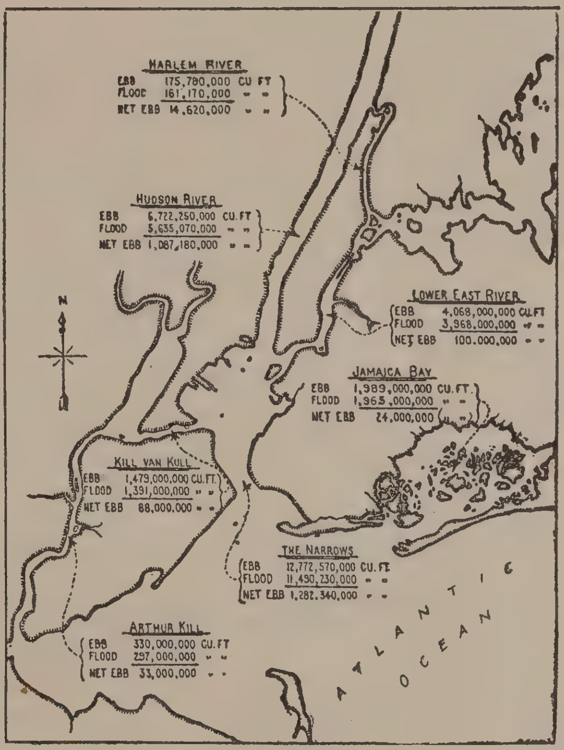

FIG. 5

Volumes of Water which Normally Flow Past Various Points in New York Harbor

TABLE I.

Volumes of Water and Tidal Flow in Millions of Cubic Feet.

Division	Volume below Mean Low Water	Tidal Prism	Tidal Flow Total Volumes each Tide	
			Ebb	Flood
Jamaica bay	2,029	1,977	1,989	1,965
Arthur Kill	1,735	743	330	297
Upper bay	12,970	2,541	12,773*	11,490*
Kill van Kull	728	150	1,479	1,391
Newark bay	1,542	1,071	1,972	1,867
Hudson river**	12,330	1,697	6,722	5,635
Lower East river	2,700	434	4,068	3,968
Upper East river	8,460	2,049	......	......
Harlem river	368	143	176	161

*At the narrows.
**Below Mt. St. Vincent.

Range of Tide. The differences in both range and time of tide sometimes cause the currents to flow in a direction contrary to that which would naturally be expected from the stage of tide. There are places where the flood current continues after the tide begins to fall, and where the ebb current continues after the tide begins to rise. At the southern end of Manhattan Island the mean range of tide is 4.4 feet. In the East river, near Long Island Sound, the range is 7.2 feet. The range of tide in New York harbor is small as compared with the rise and fall in many other cities. In Boston, Mass., the average difference in 9.6 feet between high and low tide; in Antwerp, 11.5; in London, 17.6; and in Liverpool, 21.3 feet.

Current Velocities. The greatest current velocities occur, as a rule, just below the surface of the middle of the main tidal channels. The maximum velocities which are likely to occur in the open channels of the inner harbor vary from about 3 to 5 feet per second, except in the Lower East river, where they frequently attain a rate of 10 feet per second. The velocities which are likely to be maintained for a considerable period of time vary from about 2 to 3 feet per second. There is about the same velocity during rising as during falling tides.

Currents as Shown by Floats. According to experiments made with floating objects set adrift by the Commission, the water of New York harbor is a long time in finding its way to sea. The floats were carefully constructed, so as to minimize the possible effects of wind upon them, and they were so made as to permit the velocity and direction of currents at different depths to be determined. Can floats and spar floats were employed in this work.

About 70 separate records were made. Each record represented a path covered by a float during a period varying from a few hours to 3½ days. The floats were followed by boats with trained observers who determined the position of the floats at frequent intervals, generally by means of a sextant or azimuth compass.

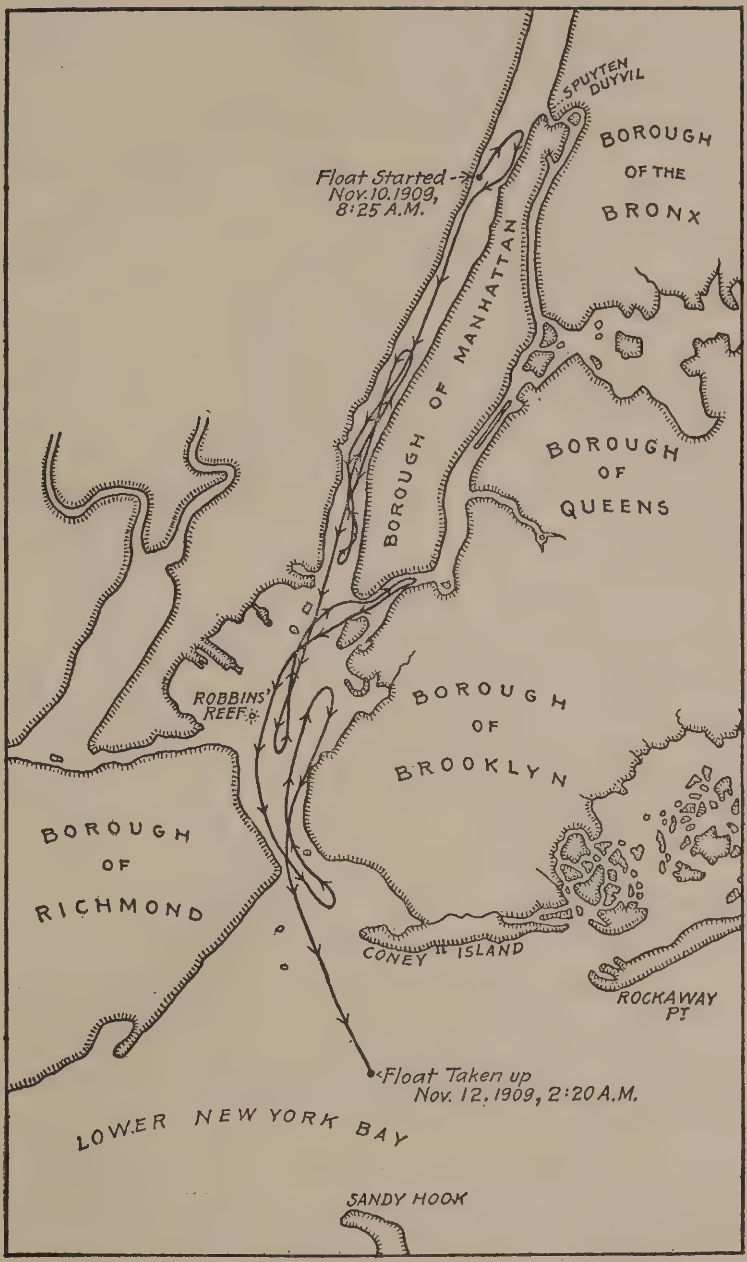

FIG. 6
Movements of a Float Started in the Hudson River

It is not necessary to describe all the records in detail. It will be sufficient here to give some of the most important results. The floats which were set adrift in the Hudson river oscillated back and forth in the Hudson, Upper Bay and Narrows until they were finally carried into the Lower bay. Fig. 6 shows the movements of a float started in the Hudson. The extent of the oscillation and the length of time taken for the floats to reach the Lower Bay were not always the same. Many of the floats set adrift in the East river remained there and in the vicinity of the stream without showing the tendency to move seaward which existed in the Hudson, as illustrated by Fig. 7. A net progression of current from Long Island Sound through Hell Gate appeared probable from the experiments, but one record covering three days indicated that at times, at least, this progression was insignificant. This remarkable record was made by a float started on December 27, 1909, in the East river, and taken up about 3½ days later. During this period the float moved between Whitestone Point and Brooklyn Bridge, doubling backward and forward on its course, as often as the tidal current changed, but without going to sea or leaving the river. The maximum velocities were 6.8 miles per hour on the flood currents and 8.6 miles per hour on the ebb, for very short periods. The interval of slack water was short. On the ebb current the float always passed to the west of Blackwell's Island on the flood it passed sometimes to the west and sometimes to the east of this island.

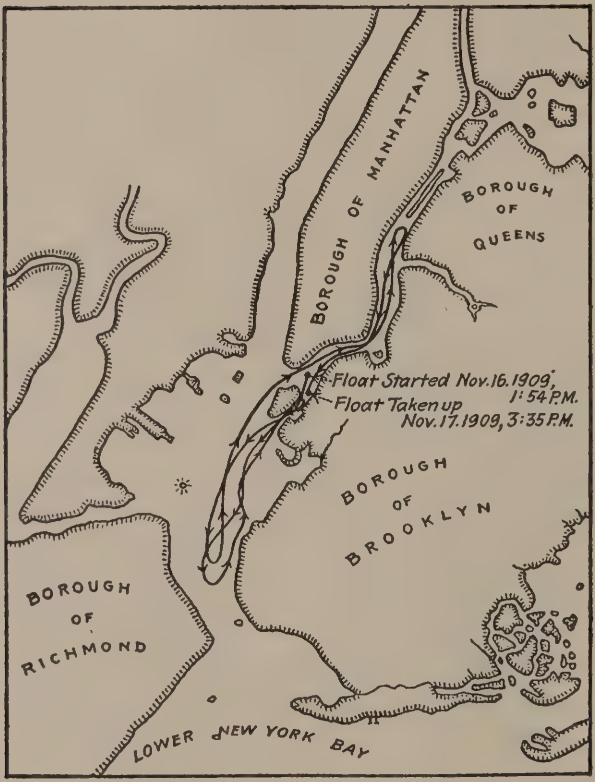

FIG. 7
Movements of a Float Started in the East River

There were 39 experiments with floats in Upper New York bay. Fifteen floats were set adrift near the proposed Passaic valley sewer outlet at Robbins Reef. This point is 3.8 miles from the Battery, 1 mile from St. George Ferry, Staten Island, and 1.5 miles from Constable Hook, New Jersey. The furthest point up the Hudson reached by a float during a single tide was 9.1 miles from the starting point; this was covered in 6 hours and 18 minutes. Going down the bay and outward through the Narrows, a float reached a point near the south shore of Staten Island, a distance of 11.2 miles from the point of beginning; this was covered in 6 hours and 30 minutes. A float passed through the Kill van Kull to Shooter's Island, a distance of 5.3 miles, in 4 hours and 38 minutes. Another went across the Upper bay to Red Hook, 2.8 miles, in 3 hours and 23 minutes. One float set adrift on February 26, 1907, landed at Quarantine. Another, set adrift on July 8, 1907, went ashore at Clifton and again at Fort Wadsworth, Staten Island; still another went ashore near South Beach, Staten Island. Of the floats which passed up-stream on the flood current, one, on July 16, 1907, landed on Liberty Island; another drifted through the Kill van Kull and went ashore on Shooter's Island, and a third crossed over the bay and went ashore at Sixty-seventh street, Brooklyn.

A study of all the results obtained with floats started at Robbins Reef in the

Upper bay leads to the following conclusions: Floating matters starting in the channel near Robbins Reef may, within a tidal period of 6 hours, reach the shores of the Hudson as far north as Sixtieth street, Manhattan, or the shores of Staten Island at any point in the Kill van Kull, Upper bay or Lower bay, as far as South Beach. With a westerly wind, they may strand on the Brooklyn shore at any point south of Red Hook, but a strong ebb current may carry them out into the Lower bay as far as Romer Shoal. It is probable that some floating matter will reach the shores of the Kill van Kull or Upper bay before passing out through the Narrows. Starting in the channel at the Narrows on the beginning of the flood current, floating material may be carried up the Hudson as far as Warren Street, Manhattan, and on the return ebb current pass out nearly to Coney Island Light. These distances depend largely on the land water flowing down the Hudson, and on the wind and tide. Ordinary velocities encountered in the Upper bay on the flood current are: mean, 1.2 miles per hour; maximum, 1.8 miles per hour. Ordinary velocities encountered in the Upper bay on the ebb current are: mean, 1.6 miles per hour; maximum, 2.5 to 3.1 miles per hour.

From a study of the action of floats in Newark bay, it was inferred that floating materials may remain during several tidal cycles in Newark bay or in Arthur Kill. The distance traveled on one tide was about 6 miles; this was covered at a mean rate of 1 mile per hour. It seems reasonable to believe that the distance traveled during a single tide in Newark bay may be 4 or 5 miles, with a mean velocity of about 0.8 miles per hour.

Floating matter may be carried through the Kill van Kull in from 1¼ to 3 hours, at a mean velocity of from 1 to 2 miles per hour, depending on the stage of tide. Maximum velocities of 3 miles per hour sometimes occur.

Float experiments made in the Lower bay lead to a number of inferences which relate chiefly to the ebb and flow of water through Rockaway Inlet, but are not of interest in connection with Upper New York bay.

In addition to the float records just referred to, some special observations were made to ascertain whether sufficient velocities existed to prevent deposition of solid matters from sewage at particular places. The places selected were near the proposed Passaic valley sewer outlets in the vicinity of Robbins Reef, at three points on the Jersey flats, in Upper New York bay and at Rockaway Inlet.

These current observations were made with double can floats set adrift from a boat anchored at the chosen location. One can floated at the surface and the other, a larger one, was sunk to a depth which could be regulated by adjusting the length of wire connecting the two cans. The velocity was determined by noting the period of time during which the float was carried 100 feet by the current. It was found that the velocity of the surface currents at Robbins Reef varied from 0.6 to 3.7 feet per second during ebb tide, and from 0.7 to 1.9 feet per second on flood tide.

Intermixture of Harbor Water. Contrary to a former belief, it has been found that the water circulates in every direction. This fact is well supported by analytical data which in amount greatly overbalance the results of the examinations upon which the earlier theories were based. It is, moreover, in accordance with a reasonable conception of the behavior of the waters as they ebb and flow through the harbor under tidal influences.

Many forces help to bring about a uniform admixture of the water. In the East river, for example, where the currents run swiftly, they frequently impinge upon the shores. At a point on the Brooklyn shore, just west of the Navy Yard, the current strikes against a bulkhead which apparently produces a complete overturning of the water to an enormous extent.

Irregularities of bottom frequently occur in the tidal channels of the harbor. The water flows over these irregularities in some cases with a velocity sufficient to force the bottom waters to the surface. Examples of this kind of mixing occur near Blackwell's Island and elsewhere in the East river.

Tide rips occur. There is a tide rip at the northwest corner of Governor's Island. Here a rapidly flowing current impinges against a large body of water flowing in another direction, with the result that a violent agitation takes place which can be seen at the surface.

When strong winds blow, the surface of the harbor is pushed over the underlying water. On reaching the lee shores, the onward-moving water sinks before the water which follows, causing a reversal of its original position.

As the water flows along the shores, it encounters piers and docks which help to bring about a vertical circulation. These structures are built upon piles which extend out from the shore line sometimes for a distance of 1,000 feet. The spaces between the piers are dredged for the use of ships, but the water beneath the piers is left at its original depth. The water that flows among the piers, therefore, must pass over a series of ridges and hollows.

The general configuration of the bottom and of the main channels of the harbor is such as materially to aid in keeping the water well mixed. Proceeding southward, the Hudson river is remarkably straight to a point opposite Thirty-fourth street, where it turns slightly and the main channel then proceeds through Upper New York bay directly toward the shore of Staten Island. The current which follows this main channel is then deflected from the Staten Island shore and passes out through the Narrows to the Lower bay, where it flows through a number of channels and over many sand-bars.

What has been said here concerning the deflection of the outgoing currents from the Hudson, and the intermixture of the water which passes out from the Narrows, applies to the East river, Newark bay and elsewhere. The configuration of the shore line and bottom, and the velocity of the tidal currents, all combine to bring about a thorough intermixture of the water.

The shape of the bottom and of the shore line suggests that the phenomenon known as the under-run does not occur in New York harbor, as a current of strongly saline water flowing along the bottom in a landward direction, irrespective of the flow of water above it. The water is usually more saline at the bottom than at the top, but the difference is usually slight and there is apparently no sharp line of demarcation.

CHAPTER III

COMPOSITION AND VOLUME OF SEWAGE DISCHARGED INTO THE HARBOR

General Characteristics. The term sewage is here used to mean the wastes which flow from dwelling houses, factories and streets through the municipal drainage systems of New York and neighboring municipalities.

In a general way, sewage in dry weather may be considered to contain about 999 parts of water and 1 part of other substance, the latter being about equally divided between organic and mineral matter. Sewage contains, besides human feces, numberless solid and liquid wastes of human and animal origin. Among the visible ingredients are garbage, matches, corks, bits of paper and cloth, and particles of human excrement.

Sewage is not constant in quality or quantity. The sewage of a residence section differs from that of a manufacturing district. The sewage produced in any locality varies both in quality and quantity at different hours of the day, different seasons of the year and with the weather. Being of such changing composition, it is obviously impossible to give figures which will carry an exact idea of the chemical or physical properties of the sewage of New York and its neighboring municipalities. Fortunately, a sufficient knowledge of the composition of the sewage can be had from figures which have been compiled for other cities.

Solid Matter. Winslow and Phelps* consider that 800 parts per million of total solids is a liberal figure for American cities and is exceeded by few. Of the total solids, from 60 per cent. to 70 per cent. are in solution, either liquid or colloidal, the remainder being insoluble matter in suspension. As to the nature of the solids, about one-half is chiefly organic matter and capable of decomposition. The residue is mineral matter.

About 50 per cent. of the organic solid matter in sewage is dissolved and the remainder is held in suspension. Of the mineral solids, 75 per cent. are present in a dissolved state. In a sewage containing total solids to the extent of about 800 parts per million, Winslow and Phelps estimate that 500 parts per million of solids are in solution and 300 parts are in suspension. Of the organic solids, amounting to 400 parts per million, 200 parts are in solution and 200 parts in suspension. Of the organic matters present, either in solid or liquid state, 150 parts per million are nitrogenous and 250 parts are not nitrogenous. The total carbon amounts to 200 parts, the total nitrogen to 15 parts, and the fats, etc., to 50 parts per million. This sewage represents the liquid wastes of a population which uses an average of 100 gallons of water per capita per 24 hours.

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*"Investigations of the Purification of Boston Sewage," U. S. Geological Survey Water Supply and Irrigation Paper, No. 185, p. 13.

It is not necessary that the composition of the sewage which is discharged into New York harbor should be accurately known in order to form a conception of the burden of pollution which is put upon these waters. The aggregate quantity of the impurities constitutes the chief matter of interest.

The quantity of solid excrement produced by an average human adult has been taken by Roechling* to be one-quarter of a pound for each discharge. The specific gravity of feces this author takes at 1.067, and from this he estimates that the bulk of a human discharge is about 0.0281 gallons. This is diluted with from 100 gallons to 200 gallons of water. Estimating the present population of New York at 5,000,000 people, there is discharged every day about 625 tons of fecal matter. Some idea of its bulk can be had from the fact that to transport this material away by rail would require a train of about 16 ordinary freight cars.

The quantity of sewage impurities can be estimated in several ways. According to figures brought together by George W. Fuller before the International Engineering Congress, held at St. Louis, 1905,† the average result of analyses of the sewage of ten cities for which figures are available indicates that the impurities are equivalent to 42.3 tons of dry solid material per year for every 1,000 inhabitants. Winslow's and Phelps' figures, prorated for New York conditions to 120 gallons per capita per day and reduced to Mr. Fuller's basis, represent 46 tons of dry solid material per year per 1,000 inhabitants.

The 1910 population in the metropolitan district was found by census to be 4,937,243 for New York and 1,486,392 for New Jersey, a total of 6,423,635. Assuming that 90 per cent. of the population was connected with the sewers, the total number of persons whose sewage entered the harbor or its tributaries was 5,780,000. The aggregate quantity of dry solid sewage material discharged in the year 1910 was therefore about 266,000 tons. About one-half of this is capable of putrefaction, or already advanced to some extent toward that condition when discharged.

Assuming one ton of dry suspended matter to be equivalent to about 45 tons, or about 53 yards of wet sludge, it appears that the population of the metropolitan district empties into the harbor each year the equivalent of 12,000,000 tons of sludge, having a bulk of 14,100,000 cubic yards. A conception of this volume may be had from the fact that if this sludge was spread out over an area equal to that of the water surface of New York harbor above the Narrows, it would raise it about two and one-half inches in one year.

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* "Passage of Excreta Through House Drains," Journal of the Royal Sanitary Institute, July, 1909, p. 216.

† Trans. Am. Soc. C. E., Vol. LIX, p. 166.

Population and Sewage Flow. The populations of the several boroughs of New York City and the average daily quantities of sewage discharging in dry weather into the various divisions of the harbor are shown by Figs. 8 and 9, respectively. The 1910 populations are as given by the U. S. Census, and the sewage flows for that year are based on the actual consumption of water. The 1940 figures are as estimated by the commission. The quantities of sewage entering the Lower bay and Arthur Kill are comparatively small and are not shown on the map. It will be seen that the quantity of sewage which will be discharged daily from New York City by the year 1940 will probably be more than twice the quantity which was produced in the year 1910.

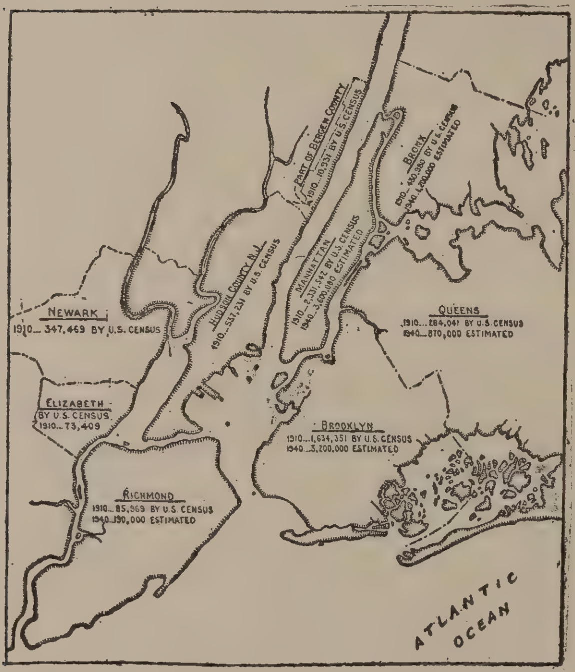
PART OF BERGEN COUNTY
1910...10,931 BY U.S. CENSUS
BRONX
1910...430,980 BY U.S. CENSUS
1940...1,200,000 ESTIMATED
NEWARK
1910... 347,469 BY U.S. CENSUS
HUDSON COUNTY N.J.
1910...537,231 BY U.S. CENSUS
MANHATTAN
1910...2,331,542 BY U.S. CENSUS
1940...3,600,000 ESTIMATED
QUEENS
1910...284,041 BY U.S. CENSUS
1940...870,000 ESTIMATED
ELIZABETH
BY U.S. CENSUS
1910...73,409
BROOKLYN
1910...1,634,351 BY U.S. CENSUS
1940...3,200,000 ESTIMATED
RICHMOND
1910...85,969 BY U.S. CENSUS
1940...190,000 ESTIMATED
ATLANTIC OCEAN

FIG. 8

Population of New York City and Part of New Jersey

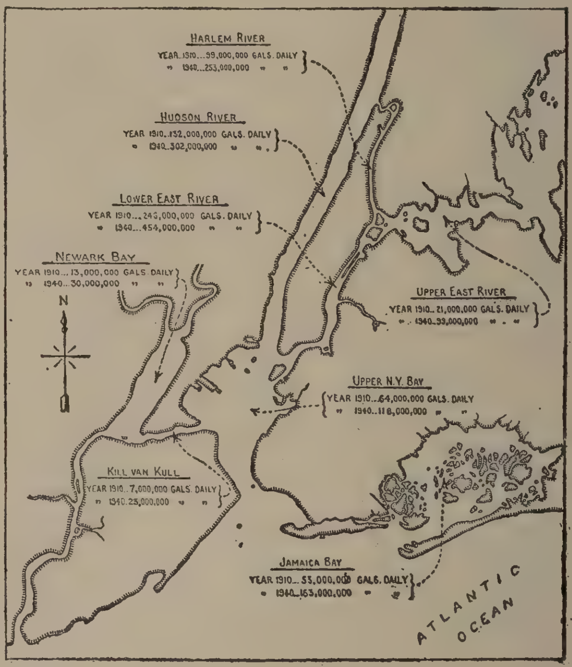

FIG. 9

Sewage Discharged into Various Divisions of New York Harbor

CHAPTER IV

APPEARANCE OF THE WATER WITH REFERENCE TO SEWAGE

Most of the sewage produced in New York City and vicinity is discharged near the center of that area in New York and New Jersey which is called by the commission the Metropolitan Sewerage District.* Here the refreshing action of the sea is least active. There is no large permanent population close to the ocean, and consequently but little sewage flows into the waters from this area.

Lower Bay. The open waters of Lower New York bay are not, at the present time, badly polluted by sewage. Quantities of driftwood and kitchen refuse may often be seen, and oily sleek is visible at times upon the waters, but solid matters readily recognized as of sewage origin do not occur regularly or frequently in any place or at any season. The shores are sometimes piled high with inflammable débris. The water is normally fairly clear and clean in appearance. Heavy rain and winds produce a general appearance of turbidity.

Jamaica Bay. In parts of Jamaica Bay the discharge of sewage is often evident to the senses. Large sewers which discharge from Brooklyn, from Far Rockaway and elsewhere make the water in the vicinity of the outfalls look turbid and greasy. Small sewers along the ocean side of the bay discharge sewage which is easily recognizable as such. A gas-works on the ocean side, a large garbage reduction plant and other industrial works near the mouth of the bay at times discharge refuse which causes large areas of sleek to form on the water.

Upper Bay. The water in the main channels of the Upper Bay is normally somewhat turbid and of an olive-gray appearance. During periods of storm, and at seasons when unusually large volumes of water are being discharged by the Hudson river, the water becomes more turbid and ocular evidence of sewage less frequent. Areas of greasy sleek are of common occurrence during much of the time. Near the shores traces of the sewage which is discharged into the waters are evident. The sewers discharge at or near the surface. Their location can generally be detected by streams of turbid liquid on the surface of the water.

Solid particles recognizable by the unaided eye as of sewage origin exist in the Upper bay, being most common near the shores where the sewers discharge and in the line of the currents which flow past the sewer outfalls. The amount of this solid material varies considerably with the stage of tide, the quantity of water moving in the harbor, the wind movement and the nearness of the sewer outfalls.

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*See Report Metropolitan Sewerage Commission of New York, April 30, 1910, p. 51.

Newark Bay. Newark bay receives on the north the highly polluted Passaic river and the Hackensack river. These are tidal streams which wind through low-lying meadow lands. Their waters are strongly affected by rains. Near its mouth the Passaic is black from the sewage and manufacturing wastes which it receives.

The water of Newark bay is always more turbid in appearance and more brown than the water of Upper New York bay. Except near the mouth of the Passaic river, and in the vicinity of some large sewers near its shores, it looks to the eye to be free from pollution by sewage. Occasionally, fields of greasy material, largely from oil works on the shores of the Kill van Kull, are carried into Newark and Upper New York bays. The waters of these two bays, however, are generally quite different in appearance.

Hudson River. Except during periods of rainfall, the water of the Hudson is but little more turbid than that of the other main divisions of New York harbor. Newark bay is generally more turbid than the Hudson. At times of heavy rain, the influence of the Hudson can be detected by the turbidity which it produces through the Upper and Lower bays, Kill van Kull and the East and Harlem rivers. This effect is, however, temporary. The run-off is rapid. It takes a heavy storm to make a visible effect upon the Hudson.

The water of the Lower Hudson above New York is not, for the most part, visibly polluted by sewage. The sewage which is discharged into the Hudson comes mostly from Manhattan Island. The water is discolored near the outfalls and between the piers; close to the shore the odor, discoloration and other evidences of pollution are often excessive.

There is little sewage entering the Hudson from New Jersey, as compared with the quantity which enters from New York, although the amount taken by itself is not inconsiderable.

Lower East River. The sewage which is discharged into the waters of the Lower East river is soon diffused. Except where piers and slips interfere with the normal tidal action, the mixing effect of the rapidly moving currents is clearly apparent. The mouths of most of the sewers can readily be detected by the discolored appearance of the water in their vicinity, and the water near shore is often visibly contaminated with solid sewage matters for several hundred feet from sewer outfalls. But, except near the shores and in some other localities where tidal scour is prevented by turns in the river, as at Wallabout bay, for example, a rapid and thorough intermingling takes place.

The water in the tidal channels of the East river is of a somewhat turbid, greenish color under normal circumstances. Solid particles, easily recognizable from passing steamboats as of sewage origin, exist in all parts and at practically all times. Greasy sleek is often conspicuously present. The water is turbid and foul-smelling in the vicinity of the sewer outfalls. In the quiet waters, between the shipping piers, an evolution of gases occurs during much of the time. Solid sewage materials are continually present in the large volumes of water which well up from great depths where the currents are particularly swift.

The Lower East river receives more sewage than does any other main division of the harbor. It receives not only the sewage of the dense population naturally tributary to it, but a great deal of the sewage-polluted water of the Harlem river.

Upper East River. The water of the Upper East river is generally clearer and cleaner in appearance than the water of Upper New York bay, and much less polluted than the water of the Lower East river. The water improves in appearance as one proceeds toward the Sound. A few large sewers discharge into the Upper East river, as, for example, at Hunt's Point. In the vicinity of the outfalls, the surface water is turbid and greasy over a large area. Fields consisting apparently of but slightly diluted sewage may extend over 50 acres or more at Hunt's Point. The fact that a nuisance exists at this point cannot be disputed.

Harlem River. The water of the Harlem is usually turbid and dark in color, bearing unmistakable evidence of the sewage which is discharged from heavily populated districts in The Bronx and Manhattan. The southern end of the Harlem river is particularly polluted. The sewage is diffused through the waters not only by the action of the natural tidal currents, but by reason of the constant movement of vessels.

CHAPTER V

WHAT BECOMES OF THE SEWAGE DISCHARGED INTO THE HARBOR

General Considerations. The whole problem of what becomes of sewage discharged into New York harbor resolves itself largely into a question of how, and to what extent, diffusion and digestion are carried on.

A consideration of the possible ways in which the sewage which is discharged into the harbor can disappear shows that the liquid and solid ingredients must be (1) mechanically transported to sea by the water, or (2) assimilated and so converted into mineral matter, or (3) they must accumulate. Research has shown that all three of these ways operate to cause the sewage to disappear.

Little need be said here concerning the mechanical transportation of the sewage materials to sea. Theoretical studies supplemented by experiments have shown that the tidal currents do not carry the sewage away with the promptness and completeness which are necessary in order to account for the condition of the water. Analytical investigations show that the sewage disappears largely by assimilation. The phenomena of assimilation are collectively termed digestion.

Studies of the phenomena of assimilation have been made in order to determine the circumstances under which the solids and liquids of sewage disappear. These investigations have been carried on partly by observations with the unaided senses, partly by analytical studies and partly by experiment. As a result, the Commission has been able to learn something of the disappearance of the solids, both those which sink and those which float. Some information has been obtained concerning the behavior of the suspended matter which neither rises nor subsides quickly. Some information, also, has been collected concerning the disappearance of the oil and grease which exist at the surface and of the liquid organic matters.

Inspection shows that, where pollution is recent and excessive, the water is rendered turbid, greasy and discolored. The hue is almost always lighter than that of the adjacent water. It varies according to the freshness and concentration of the sewage, the amount of trade waste and other factors. Where the pollution is not recent, the water is darkened and made somewhat opaque. In extreme cases the water is black. Gases are produced and rise to the surface in bubbles which break, leaving in many cases iridescent films upon the surface.

It appears that the liquid portion of the sewage which is now discharged into the harbor becomes thoroughly commingled with the water soon after it loses its identity as sewage. After it has once become mixed with a few times its bulk, it becomes difficult to recognize it by sight. Marked stratification usually does not long persist.

Immediate Visible Effects of the Discharge of Sewage. Where sewage discharges into the harbor, marked discoloration of the water usually results. The water contains many visible particles of paper, feces and other solid matters. The size of these particles varies from scarcely distinguishable objects up to solid masses several inches in length. The water, which is generally of an olive, slightly turbid appearance, becomes brownish or grayish and decidedly turbid. The discolored surface is sharply separated from the surrounding water. As the tidal current carries the sewage away from the outfall, the discolored area expands—it changes shape continually. It keeps its integrity for a long time, but the characteristically turbid hue is eventually lost by intermixture with the water beneath.

Some intermixture between the sewage and harbor water takes place from the outside edges of the discolored area, but diffusion proceeds chiefly, apparently, from the bottom of the mass of sewage. The surface of the discolored area is covered with a film of grease. This greasy film is persistent; it lasts much longer than the discolored area with which it is at first associated. Eventually the grease becomes broken up by the waves and eddies, but it long remains upon the surface in detached films varying from a few square inches to many acres in extent.

Beneath the surface of the water, after the brownish turbidity has disappeared, are small particles of paper and great numbers of minute white flakes. These flakes consist partly of insoluble soaps which have been produced by the chemical combination of soluble soaps in the sewage with the calcium and magnesium salts of the sea water.

Kinds of Undissolved Sewage Solids. The solid matters which are carried by the sewage, otherwise than in true solution, may be divided into three classes: First, the solids which continue to float for some time on the surface of the water; second, those which are long carried in suspension in the body of the tidal streams; and, third, those which sink soon after the sewage is discharged into the harbor.

Floating Matter. The solid sewage particles which float upon the surface are objectionable because they add to the organic content of the water and on account of their appearance.

During calm weather, fields of grease, floating sewage matters, wood and other débris may be seen in New York harbor. These fields are often many acres in extent and sometimes a mile or more long. They preserve their integrity with remarkable persistence and are not easily broken up by ordinary winds or waves or by the movements of vessels. There is usually solid human excrement in these floating masses.

The floating particles of sewage are not necessarily composed solely of matters which are lighter than water. Such sewage solids are often made up of aggregates, most of whose ingredients are heavier than water, but which contain enough gas to keep them at the surface.

There is a more or less constant deposit of solid matter from the sewage particles which float at the surface. Some of the disintegrating particles join the mass of material which flows in the body of the current and some descend to the bottom. The ceaseless action of the waves, the attrition which the floating particles experience in contact with other floating solids, the impact of the water against piers and other structures and the destructive effects produced by vessels, all help to disintegrate the solids and resolve them into smaller masses. The effect of these forces is plainly discernible. While large pieces of excrement are nearly everywhere observable in the Upper harbor, by far the greatest number of solid particles are of comparatively small size.

Although solid matters are broken up into smaller particles by mechanical action, actual liquefaction does not take place so much at the surface as at the bottom of the water. Putrefaction is apparently not necessary to liquefaction, but it occurs in the deposits which settle to the bottom and in water whose oxygen is entirely exhausted.

Large quantities of driftwood come to the shores, carried there by the action of the tidal currents and wind. Much driftwood is collected by poor persons and used for fuel. There are places on the shores of New York harbor where this supply is practically inexhaustible, and where men, women and children may be seen almost any day gathering wood.

On the south shore of Staten Island and on the west end of Coney Island driftwood is collected into piles and burned at the water's edge in order to get rid of it. There is a peculiarly greasy, disagreeable odor to these accumulations.

It has frequently been noted that floating solid matters often go ashore. The cause of this shoreward movement was at first thought to be due to wind alone. This was found to be an insufficient explanation to account for all the strandings, and it was then for a time believed to be caused by the movements of vessels. Later, it was observed that the floats went ashore on flood more than on ebb currents. From this it has gradually come to be believed that, aside from the winds, a principle of general application is at work to strand the floats. It seems probable that a movement of floating matters shoreward occurs in all rivers during rising stages.

When floating solids reach the shores of New York harbor, the piers, shipping basins and bays formed by irregularities in the shore line catch and hold them. These places, protected as they are from the direct force of the tidal currents, afford excellent opportunities for sedimentation.

Knowledge of the behavior of sewage in the slips makes it easy to understand why it is that the slips continually require to be dredged in order that a proper depth of water may be preserved for navigation, why the dredged material is so foul, and why it is that sewage solids accummulate between the piers even when the bottoms of the main tidal channels beyond the pierhead line are relatively free from deposits of sewage origin. This knowledge makes it easier to understand why the extension of the sewer outfalls a little further toward the center of the tidal currents produces only partial improvement.

Oil and Grease. Sewage contains nothing which is more characteristic or which alters more slowly in composition when discharged into harbor waters than oil and grease. The quantity of the greasy matter is not large, but its effects are unmistakable. Mention has been made elsewhere of the greasy sleek which sewage produces upon the surface of the water into which it is discharged. The sleek is conspicuous in New York harbor, and at times large patches of it are distinctly visible.

The sleek floats onto the shores and imparts a strong, unpleasant, greasy odor. The driftwood smells of it. Balls of grease formed in the sewers of New York have been found on the sea beaches of New York and New Jersey many miles from the city.

There are many industries situated on the shores of New York harbor which produce oil and grease and discharge it as waste into these waters. Of these, oil refineries are the most prominent.

It is probable that oil tank vessels entering the harbor in ballast sometimes pump their greasy water overboard before taking on a new load of oil. Manufacturing establishments, slaughter houses and, in fact, most factories, refineries, gas houses and industrial establishments empty their liquid wastes into these waters.

The aggregate quantity of grease wasted from private dwellings, hotels and restaurants is large, although figures are not available to show the amount. Grease enters the sewers in concentrated condition when poured, in liquid and semi-liquid form, from cooking utensils through kitchen sinks, but a continuous stream of greasy matter is contributed by the soapy water which is an invariable and prominent constituent of sewage.

Finely Divided Suspended Matters and Colloids. In the second class of undissolved sewage solids are the colloids and finely divided particles of suspended matter, the specific gravity of which is nearly that of water itself. Some of the colloids are precipitated by sea water. When allowed to settle from sewage, the precipitated colloids and solid matters form sludge or, as sometimes termed in the investigations of the Metropolitan Sewerage Commission, black mud.

Transporting Effects of Currents. The velocity of the currents into which the sewage of New York and neighboring municipalities is discharged is sometimes less than the velocity which occurs in the sewers. When harbor water backs into the sewers by reason of the rising tide, the flow is retarded or reversed. At these times, deposits take place in the sewers. These deposits are usually flushed out by the accelerated flow which takes place when the tide recedes, so that about the same amount of solid matter is emptied into the harbor as would be discharged if a uniform rate of flow were maintained. The velocity necessary in order for sewers to be self-cleansing is generally assumed by engineers to be two to three feet per second. Currents of less velocity than this permit sewage matters to be deposited, and this is true whether the currents occur in a sewer or in the harbor.

The velocity of the water into which the sewage is discharged varies considerably according to the location of the outlet and the stage of the tide. The velocity in the main tidal currents is also different in different parts of the harbor. Sometimes the sewers discharge well out from the shore, but, for the most part, the points where they empty are not in the main currents.

The studies of tidal phenomena show the greatest velocities of currents which ordinarily occur in the main tidal currents at and near the surface when the tide is running at its full strength. It is to be remembered, however, that these velocities are maintained only for a portion of the time. During the four occasions each day when the currents slacken, stop and begin to flow in the opposite direction, the velocities are not what these figures indicate. Nor are the currents ever so strong near shore or near the bottom as near the center and top of the channels.

Inasmuch as the currents stop and reverse four times a day, it is evident that the figures stated simply show what currents exist for a part of the tidal period. They do not show the existence of currents capable of keeping solid matters from settling to the bottom. In no part of the harbor do the currents flow with such velocity and uniformity as to prevent the temporary deposit of sewage solids. It is probable that deposits are alternately being formed and flushed away in some parts of the harbor. At the Narrows, the currents are slow enough to permit sewage solids to sink to the bottom during nearly 12 hours each day.

There must be a great deal of movement of sewage solids along the surface of the harbor bottom. Alluvial rivers carry a large share of their suspended matters in this way. Currents which are entirely incapable of keeping suspended matters from sinking are often abundantly able to drag or roll them along. The currents necessary to move solid particles along the bottom are very slight.

Effect of Salinity on Transporting Power. It is a fact of great importance, but one generally overlooked, that the transporting power of a river for solid particles of any kind in suspension is diminished by the presence of sea water. Water which is strongly saline will not transport as much finely divided solid matter in suspension as will water which is without salt. Rivers which discharge into the sea deposit solid matters not alone because the velocity of the current is checked by the waters of the ocean, but largely because they become more salt.

Sewage which is discharged into a tidal harbor will deposit more solids than would be deposited if the discharge took place into a land-water stream flowing at the same velocity. The capacity of a harbor for carrying sewage matters to sea, therefore, cannot be estimated safely from information obtained merely from a study of inland rivers.

In order to compare the relative rate at which sewage sludge deposits in land and sea water, the Metropolitan Sewerage Commission made a number of experiments, the results of which show that deposits take place much more rapidly in sea water than in land water.

Two bottles were nearly filled, with sea water in one case and land water in the other. An equal quantity of sewage sludge was then added to the water in each bottle. The bottles were thoroughly shaken and set upon a table to permit the deposit to settle out.

At the end of half an hour the water in the bottle containing sea water was noticeably clearer than the other water. At the end of one hour the difference was marked. A heavy deposit had settled upon the bottom of the bottle containing sea water and the supernatant water was clearing rapidly. There was little change in the bottle containing land water. At the end of two hours there had been little improvement in the appearance of the land water mixture since the beginning of the experiment. Most of the sludge had settled to the bottom of the sea water and the sea water was clearer.

At the end of three hours some deposit was visible at the bottom of the land water, but the water itself was not as clear as the sea water had been at the end of the first half hour. The sea water had deposited practically all the sludge which had been put into it. As nearly as could be estimated from inspection, the sea water had deposited its suspended matter more than twelve times as rapidly as had the land water.

Heavy Suspended Matter. Sludge Deposits. The third class of undissolved sewage particles, those which sink as soon as the sewage is discharged into the harbor water, finds a lodgment on the bottom which is permanent or temporary according to a number of circumstances. Among these circumstances, the weight of the particles, the velocity of the tidal current into which they are discharged and the smoothness or roughness of the bottom are the most important factors.

Analyses made by the Metropolitan Sewerage Commission have shown that deposits of sewage solids exist not only in the immediate neighborhood of sewer outfalls, but at considerable distances from the sources of contamination. In the Lower bay, deposits of black, muddy material, much of it bearing evidence of sewage contamination, occur in and near the main channels at some distance from shore. The bottom of Upper New York bay is almost entirely underlaid by deposits of black mud. The analysis of about five hundred samples of deposits from this part of the harbor has demonstrated the presence of solid materials of sewage origin over nearly the entire bottom. The bottom of the Harlem contains extensive deposits of black, muddy material in which solid matters of sewage origin are easily found.

The only parts of the harbor which are not contaminated by sewage sludge are those where the tidal currents are too swift to permit deposits to form. Most of the bottom of the Lower bay, the Upper Hudson and the Long Island Sound approaches to New York are covered with sand, silt, and unpolluted mud. The water of the Lower East river flows too swiftly for deposits to accumulate in the channels. The investigations upon which these statements are made have been extensive. Over 1,100 samples have been collected from the bottom and carefully analyzed to determine the extent of the pollution. The bottom has been penetrated to a depth of ten feet, and samples have been collected which show that sewage solids have been deposited to at least that depth. Wherever tidal conditions permit sediment of any kind to accumulate, pollution with sewage takes place.

The material at the surface of the bottom of New York harbor varies considerably in composition at different places. Taking a standard United States Government Chart of the harbor as a basis, areas described as "soft," "sticky," "mud" and "ooze" were outlined and colored by the Metropolitan Sewerage Commission. These colored areas showed interesting results. Above the Narrows the hard areas were found to be all situated well out from the shores and the softer areas were near the land. Below the Narrows this order was reversed. This suggested that the soft sewage matters which originate near the shores of the harbor above the Narrows were flushed out by the tidal channels into the Lower bay where the currents even in the main tidal channels were not sufficiently strong to prevent the sewage matters from depositing.

Accumulations of sewage deposits are difficult to handle except by pumping. When raised in the bucket of a dredging machine, much of the mud flows back into the water from which it is taken. The United States Government, in dredging Ambrose channel, now the principal entrance to New York harbor from the sea, made use of suction dredges and pumped large quantities of sludge, as well as sand, into sea-going vessels which transported it to the open ocean.

Effect of Currents on Deposits. A slight current has sufficient force to move the light sewage particles which settle upon the surface of the harbor bottom. This is well illustrated by the fact that the deep permanent deposits do not rapidly increase in the main tidal channels of the rivers nor upon a large part of the flats in Upper New York bay, although suspended matters are undoubtedly present in the water. The currents over the flats attain a velocity of about one foot per second at ordinary tides, and this, apparently, is sufficient to keep them free from sewage débris.

The capacity of water to move solid matter from a condition of rest on the bottom of a stream varies with the sixth power of the velocity of the stream. If the velocity is doubled, the increase in the force which is capable of putting the particle in motion is multiplied 64 times. This power of a stream to move or roll solid matters along the bottom accounts, in part, for the formation of sand bars at the mouths of rivers, as well as for the movement of gravel and other heavy solids along the beds of streams. Solid material, such as accumulates near the mouths of sewers, is continually being moved in this way by currents.

CHAPTER VI

DIGESTION OF SEWAGE

Putrefaction of Sludge Deposits. There are reasons for believing that the deposits on the bottom of New York harbor make a considerable demand upon the oxygen. In some parts of the harbor, bubbles of gas rise continually to the surface. This condition, when active, is termed effervescence. It is common along practically the whole of the built-up waterfront of the harbor above the Narrows. It is most active in the neighborhood of sewer outfalls, but it extends throughout the open waters of some of the smaller arms of the inner harbor, such as the Harlem river, and has been observed in some of the main tidal channels. Such bubbling as occurs in the larger tidal channels or broad arms of the harbor is likely to pass unnoticed, because of the movement of the waves. The bubbles are usually small, although, in some cases, several inches in diameter, and are often accompanied by masses of solid, black sludge which sink back into the water when the bubbles burst at the top.

Bubbling rarely, if ever, is due to the condition of the water itself. It originates in solid matter at the bottom. By stirring up the bottom, the ebullition of gas is greatly increased.

Deposits of putrefying matter on the harbor bottom containing sewage substances vary in consistency from a thin, watery mud to a relatively compact and solid mass. The densest material is below and the lightest on top. The consistency at and near the surface is relatively liquid. The surface of the deposit is often indefinite for the reason that the deposit merges in consistency into the water above it. Only relatively dense and compact deposits exist in the open channels where the currents flow freely.

Whatever the consistency of the deposit, the nature of the putrefaction and the consequences to the overlying water appear to be much the same. Assuming a deposit of such consistency as to preserve its integrity and position beneath a current of water of, say, 1 foot per second, the following conditions are present: The material is black, the color being due to sulphide of iron. Iron is almost universally present in nature, and in the deposits it assumes the fine, black, granular form of the sulphide. All the oxygen available has been used up, not only that which was present in solution, but that which was available in chemical combination with other elements.

The surface of the deposit is not black. It may be gray or brown or some other color, depending upon the composition of the deposit aside from its sewage content, but it is not black like the material under it. The lighter color at the surface is due to the fact that the top is in contact with the water which contains oxygen.

Below the surface, putrefaction is carried on through the action of bacteria. There is a limit to this action. It can proceed only while the solid and semi-solid substances acted upon are in circulation. It is probable that the products of bacterial life on the mass prevent the further activities of the organisms. Only when the mass is in circulation can the products be carried off and the bacteria resume their activities.

Circulation is provided for by the evolution of gas. The gas bubbles, rising, stir up the deposits and enable the putrefactive changes to be resumed with undiminished activity. It is necessary, however, for the gas bubbles to be free to rise. In the lower and more compact parts of the deposits, the sludge is too dense for the gas to escape, in consequence of which putrefaction proceeds with slowness, if at all. Putrefaction is most active near the top.

The rate at which putrefaction proceeds depends not alone upon the amount of circulation which may be possible in the sludge by reason of the escaping gas. Temperature has a bearing upon the process. Cold retards putrefaction and warmth accelerates it. It is doubtless for this reason that bubbling is more active in summer than in winter.

The phenomena of putrefaction in the deposits on the harbor bottom are analogous to those which take place in sewage sludge. There seems to be little difference in the process or in the results. The final product is a somewhat granular mass of dark-colored, inoffensive material which is capable of flowing freely like water so long as it is wet and which parts with its water readily and forms an inoffensive mass when suitably drained and dried. It is the presence of putrefaction, leading to this permanent and stable condition, which is objectionable.

The liquefaction of solids in the absence of oxygen is attended by the production of offensive-smelling gases. The gases take the form of bubbles which rise to the surface. In so doing, the bubbles often carry back masses of deposit toward the surface. Bubbling is a constant phenomenon in the slips of Manhattan Island. So active is it in places that the water takes on the appearance of effervescence accompanied by a sound like rain falling upon the water.

Actively assisting in the mechanical disintegration of sewage sludge at the bottom are multitudes of minute animals and plants, including the infusoria. These propagate in vast numbers in the sludge and by their activities tear apart, and render still more minute, particles of solid matter which contain enough organic material to serve them as food. Some of these organisms require a considerable supply of oxygen and live at the surface of the deposits while others are able to exist with a very small supply of it and do their work beneath the surface.

The odors caused by the putrefaction of the deposits are the most offensive of any odors produced by the discharge of sewage into the harbor. Offensive, also, and more prevalent, is the peculiar greasy odor. This odor is noticeable along the whole shore line of the inner harbor, particularly near beaches.

The odor of fresh sewage is generally musty and not unlike that sometimes noted in damp cellars and other enclosed places which are in need of proper ventilation. This musty odor is doubtless produced by molds, enormous growths of which have been found by the Commission in some of the sewers of Manhattan. Sewer air is usually warm and saturated with moisture, for which reason the odors present are especially noticeable. The odor of sewage is familiar to the people of New York, for the sewers are ventilated through manholes and catch basins in the streets, and some of these streets are daily crowded with people from curb to curb. Many large buildings discharge spent steam into the sewers, with the result that clouds of vapor possessing the odor of cooked sewage are discharged into the streets.

Reference has been made to the action of bacteria and minute animals in breaking up the solid particles of sewage and liquefying them. The liquid so produced, as well as the liquid natural to the sewage, passes through certain chemical changes while undergoing assimilation. Nature requires that all organic matters be resolved into stable mineral forms. In this final shape matters of sewage origin are not offensive, and are incapable of becoming so. They are oxidized.

Oxidation of Organic Sewage Matters. About 50 per cent. of the organic matter of sewage is present in liquid form. Beside this, it is to be noted that all solid organic matters must assume the liquid form before they can be assimilated. The most significant process concerned in assimilation is therefore oxidation.

The oxidation of sewage takes place in several ways:

First, there is a small amount of direct oxidation of certain liquid chemical substances in the sewage. The oxygen for this reaction is that which was contained in the water with which the sewage is mixed.

Second, bacterial action may oxidize directly another portion of the liquid organic matter and abstract more of the dissolved oxygen. If sufficient oxygen is present, the process takes place without producing foul odors.

Third, liquid and solid organic matters broken down by putrefactive action produce unstable compounds which must later become oxidized. If there is an insufficient amount of dissolved oxygen present, it will be abstracted from compounds containing oxygen, if available.

The oxidation of organic matters is essentially a process of combustion. Oxygen is required and carbon dioxide is produced, as are ammonia and water. Finally, the ammonia is oxidized to nitrous and nitric acids, and these, uniting with alkaline substances natural to the water, form nitrites and nitrates, respectively. In sea water, nitrites, and especially nitrates, appear to be sparingly formed.

The oxygen which is available for the oxidation of the impurities is that which is dissolved in the water and in dissolved chemical compounds containing oxygen. The ultimate source of the dissolved oxygen is the atmospheric air with which the water has been in contact.

The depletion and replenishment of the oxygen available for oxidation purposes are taking place continually. The original water or carrier portion of the sewage is originally saturated with oxygen. As the sewage flows towards its discharging point, the dilution may be so small and the time so long that a large part of the original oxygen may be consumed.

The discharge into the harbor of a sewage deficient in oxygen dilutes, so to speak, the dissolved oxygen of the receiving water. This operates to deplete the amount of oxygen per unit available. The demand for oxygen, by those products of putrefactive decomposition which are formed in the sludge at the bottom of the harbor, causes a further depletion of the dissolved oxygen.

The chemical changes, and particularly the absorption of oxygen, which occur during digestion of sewage by water, have been investigated by Professors Letts and Adeney of Ireland and made the subject of an exhaustive report to the Royal Commission on Sewage Disposal of Great Britain. The work of these investigations was based on the well-known researches of Frankland, which showed that the essential cause of change was one of oxidation, and those of Dupré, who proved that oxidation was dependent upon the activities of bacteria.

It appears that the significance of the presence of sewage matters in water depends not alone on the quantity and chemical composition of those wastes, but also upon the fermentative properties of the mixture of water and sewage. Letts and Adeney have likened the purification of sewage in sea water to a physiological process analogous to the respiratory action of higher vegetable organisms.

There are two stages of decomposition when sewage is discharged into water, according to Letts and Adeney. In the first, the organic matters are first fermented completely. The products of this fermentative change are carbonic acid and ammonia and organic substances possessing the chemical and physical properties of the humus of cultivated soils. In the second stage of decomposition, the humus matters and the ammonia compounds are further fermented, the resulting products being carbonic acid, nitrous and nitric acids and water. The central feature of the first stage is the oxidation of organic carbon to carbon dioxide and the central feature of the second stage is the oxidation of the ammoniacal nitrogen to nitrous and nitric acids. The self-purification of sewage-polluted water ultimately resolves itself into a question of oxidation.

The amount of dissolved oxygen in the water of an unpolluted tidal harbor consisting of half sea water and half land water is 6.15 cubic centimeters per liter at 18 degrees Centigrade. Letts and Adeney state that it can be reduced to 3.45 cubic centimeters per liter, temporarily, at least, without danger of killing fish. Below this point it appeared unwise to exhaust the oxygen, due reference being had not only to the importance of fishing interests, but also to the necessity of maintaining a wide margin of safety against the exhaustion of oxygen and the consequent production of putrefactive odors.

Oxygen is replenished slowly from the atmosphere. The rate of absorption varies, according to Letts and Adeney, between 0.08 c.c. per liter per hour for sea water and 0.03 c.c. per liter per hour for land water at ordinary summer temperatures, and may be taken as 0.055 c.c. per hour for water such as that in the harbor of New York when the latter contains equal parts of sea water and land water. The experimental conditions upon which these results are based were obtained by breaking the surface of the waters either by a discharge of air 3 inches below the surface of the waters or by a mechanical stirrer. The results seem also based upon the assumption that no oxygen is present in the water to start with. The waters of New York harbor are not ordinarily so much broken by the wind action, and the absorption of oxygen by water already holding some oxygen will be slower than where the oxygen is entirely gone to begin with. Assuming, however, that these favorable conditions indicated by the experiments obtain, it appears that an admixture of sewage which would not cause a greater draft upon the oxygen than 0.055 c.c. per liter per hour would not cause exhaustion and lead to putrefactive changes.

As a practical result of their studies, Letts and Adeney concluded that the dissolved oxygen in harbor waters is generally not in danger of being completely absorbed in forty-eight hours if the waters are mixed with sewage in the proportions of 20 to 1, provided that the solid matters have been separated by simple subsidence and the sewage does not contain appreciable quantities of directly oxidizable substances. This opinion is in accord with American experience where sewage has been discharged into rivers.

The study of rivers in America has shown that to avoid exhaustion of oxygen, the dilution must be in the proportion of, at least, 20 or 25 parts of water to 1 part of ordinary sewage, although there may be conditions where nuisance may arise when the dilution amounts to nearly 50 parts of water to 1 part of sewage. Whether sea water will absorb more sewage than land water without producing a nuisance has not yet been definitely determined in a practical way, although it seems certain that land water, gallon for gallon, is capable of disposing in a normal manner of more sewage than will sea water. It is worth bearing in mind in this connection that sea water, when saturated with oxygen, contains nearly 20 per cent. less oxygen than land water under the same conditions.

The absorption of atmospheric oxygen by water proceeds rapidly from the surface downward once it has penetrated the surface, according to Letts and Adeney. These authors believe that as soon as oxygen is dissolved by the water at the surface, it is drawn rapidly throughout the depth of the water.

The assimilation of sewage matters proceeds satisfactorily only so long as a supply of oxygen is available. When the oxygen becomes exhausted, putrefactive changes set in and offensive odors are produced. These odors are particularly disagreeable when putrefaction takes place in sea water. In this case the demand for oxygen is so great that various compounds of oxygen, which under ordinary circumstances are stable, are destroyed for the oxygen which they contain.

In order to employ the great volume of water flowing in and out of New York harbor so as to dispose of sewage without producing a nuisance, there is required the fulfillment of, at least, two main conditions:

First, the sewage must be mixed with the water before the sewage creates a nuisance.

Second, the quantity of sewage must not be too great for the quantity of water with which it is mixed.

The presence of minute particles of suspended matter well distributed through the volume of the main tidal currents is in itself the least objectionable feature connected with the disposal of sewage by diffusion. But the accumulation of these small particles upon the bottom forms extensive masses of sludge and renders large arms of the harbor water black and foul-smelling.

Large particles which float upon the surface are offensive to the sight and, when broken up, form smaller particles which are carried in suspension or deposited. Yet the total quantity of the large suspended particles is not great when compared with the total quantity of solid organic matter carried beneath the surface.

The heavy particles carried by sewage, notably sand and other solid substances which rapidly deposit near sewer outfalls, are, for the most part, inorganic in composition and contribute but little directly to the offensiveness of the water. Yet, as

Dunbar* has remarked, it may be a mistake to regard mineral matter, like sand from sewers, as unobjectionable because of its original inorganic composition. The mineral particles are covered with organic matters which are putrescible. When sand from sewers accumulates in quantity, it may give rise to unpleasant odors.

The grease which flows upon the surface and is deposited upon the shores gives rise to peculiar and unpleasant odors and is unsightly in appearance, but its worst effect is local. It is not to be compared in offensiveness with solid floating particles of excrement, or, in potential harm, with the other organic impurities which are in solution and suspension in the harbor waters.

The organic matters which are in solution, and the solids which are capable of producing compounds which make a direct demand upon the oxygen in the water, constitute the principal objections which may be raised against the discharge of sewage into New York harbor, except from the danger of infectious bacteria.

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* "Principles of Sewage Treatment." By Prof. Dr. Dunbar, 1908, p. 47.

CHAPTER VII

STATE OF THE WATER AS SHOWN BY THE DISSOLVED OXYGEN

Dissolved Oxygen as a Measure of Sewage Pollution. In seeking to get comparative figures to represent the relative intensity of pollution in the different parts of the harbor, the Commission decided in the year 1909 to make tests of the amount of dissolved oxygen in the waters, instead of undertaking the usual estimations of the nitrogen compounds. The considerations which led to this change of procedure were the far greater rapidity with which the oxygen tests could be made, the uncertainty of the occurrence of nitrates in salt water, and the more direct indication of the extent of pollution furnished by dissolved oxygen determinations.

There is no single test which, when applied to the water of any part of the harbor, shows the concentration of sewage pollution which there exists. A fresh discharge of sewage produces quite a different set of conditions from that which occurs when the pollution has reached the black, fermenting stage.

It seems probable that the forms of life which exist in the water vary and that the bacteria which are present in the freshly discharged sewage may be quite unlike those which are present where black, septic conditions occur. At the outset of its work, the Commission made careful search for a scheme of analysis which would convey some knowledge of these conditions and serve as a measure of the intensity of pollution.

Fortunately, investigations concerning the assimilation of sewage matters in tidal estuaries had recently been carried on in Great Britain under the auspices of the Royal Commission on Sewage Disposal. Through the courtesy of one of the investigators for the Royal Commission (Adeney), the attention of a member of the Metropolitan Sewerage Commission (Soper) was attracted to the importance of noting the demand which the sewage made upon the dissolved oxygen in the waters. Dissolved oxygen determinations had long been a matter of more or less regular routine in water and sewage investigations in America, but it remained for the Royal Commission on Sewage Disposal to show, through the studies of Letts and Adeney, the central importance which attaches to this subject.

Briefly stated, the digestion of sewage by water involves a liquefaction of the solids and oxidation of the liquids. Oxidation is the final stage in the destruction of all organic and nitrogenous matter, irrespective of its origin. It is a necessary step in the economy of nature and it proceeds whether the substance is discharged into water or upon land. Oxidation is a burning process and the complete disappearance of sewage matters in water may be regarded as slow combustion. So long as there is a sufficient quantity of oxygen present, the offensive and potentially offensive ingredients of sewage are disposed of by natural agencies, with the production of conditions to which there can be little or no objection. When the oxygen becomes exhausted, putrefaction sets in, accompanied by the production of foul odors and a black discoloration of the water. If the water of New York harbor should be so charged with sewage that the oxygen would fall to zero, the harbor would be in a condition resembling that of a cesspool.

There are some limitations to the useful application of dissolved oxygen tests as a measure of sewage pollution. For example, the amount of dissolved oxygen present is much greater in a fresh mixture of sewage and water than in the same mixture after it becomes old. The reason for this is that some time is required for the fermentative changes to make their full demand on the oxygen. In this case the amount of dissolved oxygen present gives no indication of the bacterial state of the water.

Again, the presence of disease germs is not indicated by the dissolved oxygen test. There may be as many typhoid organisms present with a large supply of oxygen as where no oxygen whatever exists. The amount of dissolved oxygen in a sample of water tells nothing of the appearance of the water with reference to the presence of large, solid matters of sewage origin, of oily sleek or of marked turbidity.

With proper reservations, however, the amount of dissolved oxygen present is of great service in forming an opinion concerning the intensity of pollution. It is, in fact, the most serviceable single test of tidal water which can be made to determine the intensity of sewage pollution. When applied over a sufficient period of time and through a sufficient range of conditions, it indicates well the burden of pollution by showing how rapidly the demand for oxygen is being made.

Applied to New York harbor, the dissolved oxygen figures show well the burden of pollution which is being carried. In the open ocean, outside of Sandy Hook, the amount of oxygen present is 100 per cent. of the normal. Long Island Sound, east from a point just beyond the limits of New York City, and the other open bodies of water traversed in going from New York to Boston, have been found to be saturated with oxygen.

The amount of dissolved oxygen in the water of the Hudson river, as it crosses the boundary of New York City near Mount St. Vincent, has been found to be from 70 to 90 per cent. of the amount which would be present if the water were saturated.

Studies have been made to determine whether all the deficiency in oxygen discovered in New York harbor was attributable to sewage. For this purpose, samples have been collected not only from the ocean, Long Island Sound and Massachusetts bay, but from a number of uncontaminated bays and creeks in some of which natural vegetation was luxuriant. The result of these tests has been to show that, except where decomposition of an obvious kind was making a demand upon the oxygen, the waters contained all the oxygen which they should have to be saturated.

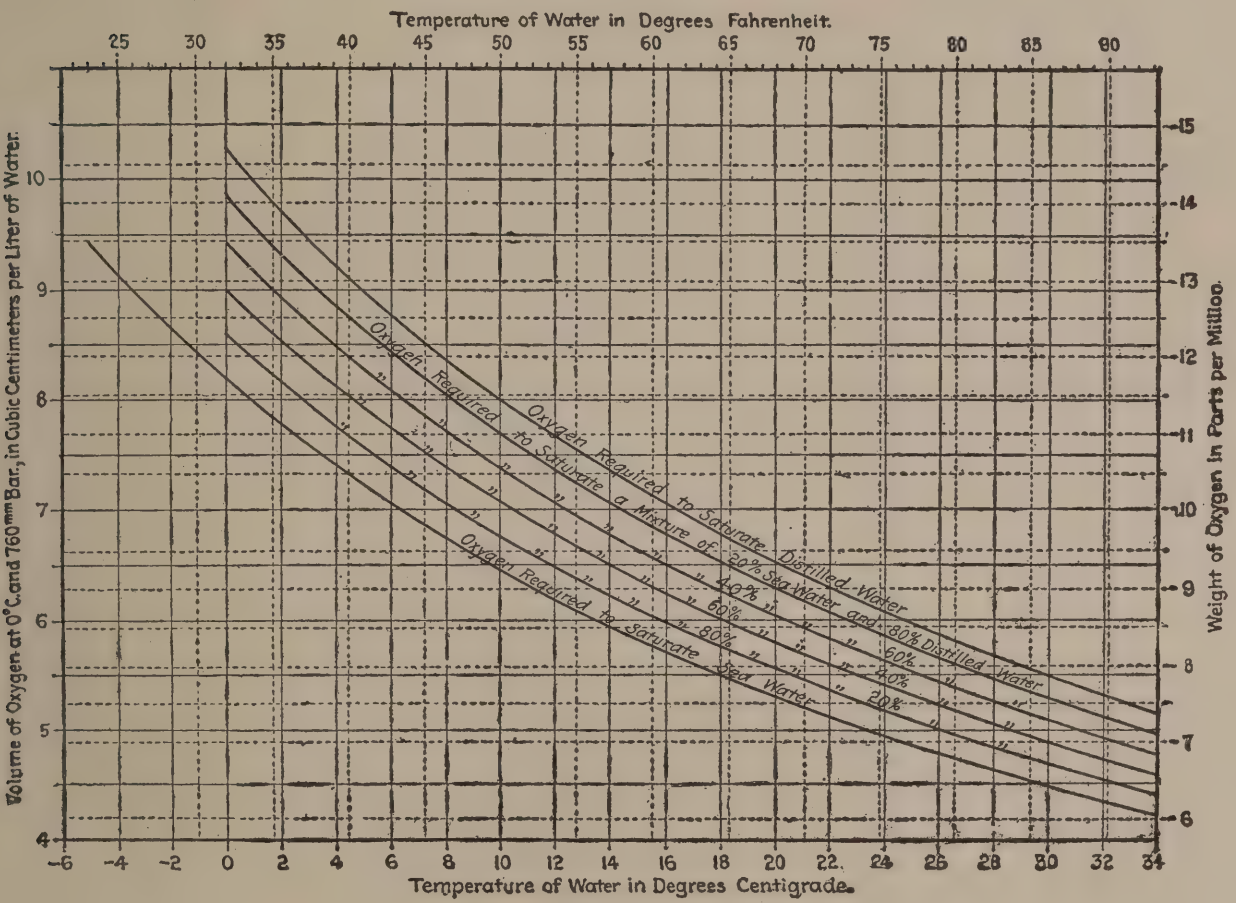

FIG. 10

Amount of Oxygen Required to Saturate Distilled Water, Sea Water and Mixtures thereof

The methods of collecting and analyzing samples have been described in detail in Part III, Chapter III. The amount of oxygen in per cent. of saturation was computed from a diagram of which Fig. 10 is an abbreviation. This diagram, based on the table here given, shows the amount of oxygen required to saturate sea water and distilled water, and various mixtures of the two, at all temperatures up to 93° Fahr. They are based on the figures published by the Royal Commission on Sewage Disposal, in their Fifth Report, Appendix VI, 1908, page 58.

TABLE II

Volume of Oxygen at 0° C. and 760 mm. barometer required to saturate sea water, distilled water and mixtures of the same, in c.c. per liter.

Temperature Centigrade	Sea Water *	Dist. Water *	Sea Water 20% Dist. Water 80% †	Sea Water 40% Dist. Water 60% †	Sea Water 60% Dist. Water 40% †	Sea Water 80% Dist. Water 20% †
—5°..........	9.42	—	—	—	—	—
—4°..........	9.14	—	—	—	—	—
—3°..........	8.89	—	—	—	—	—
—2°..........	8.63	—	—	—	—	—
—1°..........	8.40	—	—	—	—	—
0°..........	8.18	10.24	9.83	9.42	9.00	8.59
1°..........	7.97	9.97	9.57	9.17	8.77	8.37
2°..........	7.77	9.71	9.32	8.93	8.55	8.16
3°..........	7.58	9.46	9.08	8.71	8.33	7.96
4°..........	7.39	9.22	8.85	8.49	8.12	7.76
5°..........	7.22	8.99	8.64	8.28	7.93	7.57
6°..........	7.05	8.78	8.43	8.09	7.74	7.40
7°..........	6.90	8.57	8.24	7.90	7.57	7.23
8°..........	6.74	8.37	8.04	7.72	7.39	7.07
9°..........	6.59	8.18	7.86	7.54	7.23	6.91
10°..........	6.45	8.00	7.69	7.38	7.07	6.76
11°..........	6.31	7.82	7.52	7.22	6.91	6.61
12°..........	6.19	7.66	7.37	7.07	6.78	6.48
13°..........	6.06	7.50	7.21	6.92	6.64	6.35
14°..........	5.94	7.35	7.07	6.79	6.50	6.22
15°..........	5.83	7.20	6.93	6.65	6.38	6.10
16°..........	5.72	7.06	6.79	6.52	6.26	5.99
17°..........	5.61	6.92	6.66	6.40	6.13	5.87
18°..........	5.51	6.78	6.53	6.27	6.02	5.76
19°..........	5.41	6.66	6.41	6.16	5.91	5.66
20°..........	5.31	6.53	6.29	6.04	5.80	5.55
21°..........	5.22	6.41	6.17	5.93	5.70	5.46
22°..........	5.13	6.30	6.07	5.83	5.60	5.36
23°..........	5.04	6.18	5.95	5.72	5.50	5.27
24°..........	4.95	6.07	5.85	5.62	5.40	5.17
25°..........	4.87	5.97	5.75	5.53	5.31	5.09
26°..........	4.79	5.87	5.65	5.44	5.22	5.01
27°..........	4.71	5.77	5.56	5.35	5.13	4.92
28°..........	4.64	5.68	5.47	5.26	5.06	4.85
29°..........	4.55	5.58	5.37	5.17	4.96	4.76
30°..........	4.50	5.495	5.30	5.10	4.90	4.70
31°..........	4.43	5.41	5.21	5.02	4.82	4.63
32°..........	4.36	5.32	5.13	4.94	4.74	4.55
33°..........	4.30	5.24	5.05	4.86	4.68	4.49
34°..........	4.23	5.16	4.97	4.79	4.60	4.42
35°..........	4.17	5.08	4.90	4.72	4.53	4.35

*** From Lett's Table of Dittmar's Experiments, Royal Com. on Sewage Disposal, Fifth Report, Appendix VI, 1908, p. 58.**

† Interpolated between values for sea and distilled water given in first two columns of this table.

Per Cent. of Saturation in Various Parts of the Harbor. In general terms, the inner harbor has been shown by the dissolved oxygen analyses to be heavily polluted by sewage. While the water of the Lower bay contains over 90 per cent. of dissolved oxygen, the water in the middle of the Upper bay has about 70 per cent., that of the Lower East river about 55 per cent., and that of the southern part of the Harlem river only about 30 per cent. These figures represent warm weather conditions. They show the quality of the water during the comparatively dry seasons of year when the discharge from the Hudson river is at a minimum. It is, of course, at this time that the condition of the water with respect to dissolved oxygen is of most importance.

Effect of Direction of Current. The water of the incoming tide is usually better than the water of the outgoing tide, at almost all points in the harbor. In many instances this difference is not great. The least improvement occurs in the Lower East river where the pollution is relatively intense. Here the volume of tidal water is large and the importance of keeping the water clean is apparent.

Differences at Different Depths. There is generally but little difference in the amount of dissolved oxygen present at different depths. The water near the surface generally contains slightly less oxygen than the water near the bottom; but, for the most part, there is enough intermixture to prevent stratification. This condition is reversed in the Hudson near Mt. St. Vincent; in this part of the harbor the purest water is usually near the surface.

It would seem that if sewage deposits exist, they must putrefy, and in so doing set free bacteria and products of decomposition which make a demand upon the dissolved oxygen in the water, and that if these conditions occur, their presence should be apparent through the oxygen analyses. The bottom of the harbor is, however, being swept continually by the water and the circulation is apparently neutralizing whatever inequalities in the water the putrefaction of the deposits produces.

When samples have been taken at several points across a stream and at various depths, there has usually been less oxygen found near the shores and near the surface than elsewhere. These differences have been comparatively slight. The small difference has apparently been due largely to the fact that the samples for analysis have purposely been taken at a considerable distance from shore to avoid the obvious contamination which there occurs. It has been found that much of the sewage which is discharged along the immediate water-front clings to the shore and is carried along by the tide without promptly mixing with the main body of water in the more open parts of the channels. This is particularly true where the sewers empty at the bulkhead line.

Conditions in Slips. The water which lies between the docks and piers and in the canals and creeks and smaller rivers in the metropolitan district is not renewed with sufficient promptness to allow crude sewage to be discharged into them. Since these places receive more polluting matter than do the open waters, it is reasonable to require that they should be kept particularly clean. The water is often practically devoid of oxygen, a condition which is invariably accompanied by a state of pollution which is apparent to the unaided senses.

Number of Analyses Made. The total number of analyses for dissolved oxygen made by the Metropolitan Sewerage Commission in and near New York harbor was about 2,670. Of this number about 800 were made in the year 1909 and the remainder in 1911. Figs. 11 and 12 show the locations where samples were collected.

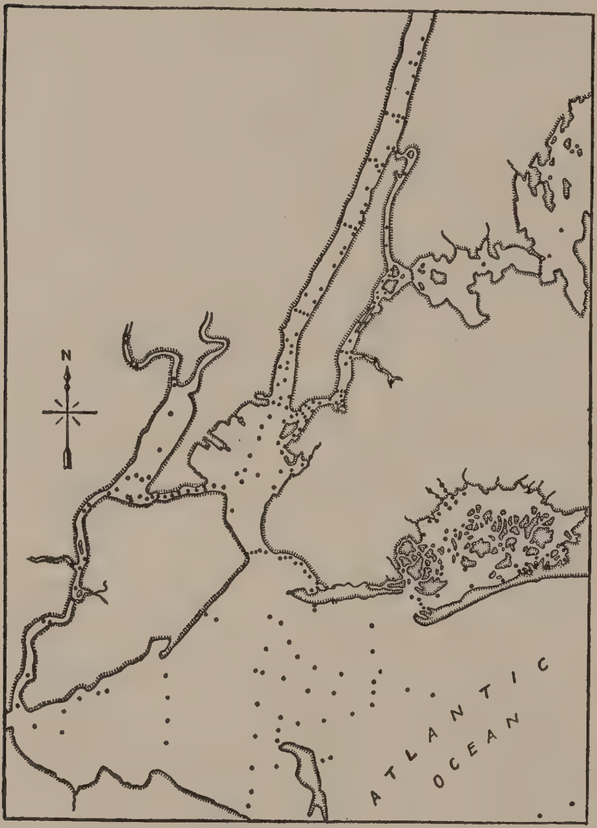

FIG. 11
Locations where Samples for Dissolved Oxygen were taken in 1909

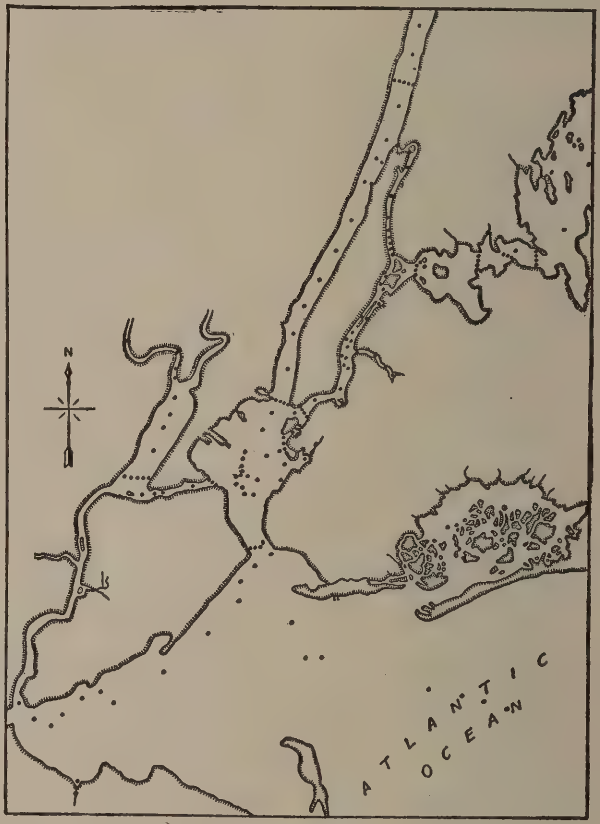

FIG. 12
Locations where Samples for Dissolved Oxygen were taken in 1911

In some respects the results obtained in the two series of investigations are comparable. The method was identical and the technique was performed by the same analyst. In both cases most of the work was done during the summer months. It appears that there was less oxygen in the water during the year 1911 than in 1909.

General Results of 1911 *Work.* A general idea of the results of the analyses made by the Commission in the year 1911 may be had from the following figures, which are averages for the whole body of the tidal stream and represent the conditions which existed during dry summer weather:

Narrows	64-89 per cent. of saturation.
Mouth of Hudson	51-64 per cent. of saturation.
Mouth of East river	50-64 per cent. of saturation.

Such differences as occur at different hours of the day were not indicated in the results. If any existed, they were obscured by differences which were apparently due to tidal currents. There was no difference observed at the mouth of the East river between morning and evening conditions at the same stage of tide. Such a difference would be expected here if it existed anywhere.

Equalizing Effect of the Upper Bay. Upper New York bay appears to be a great equalizer so far as oxygen is concerned. For this reason, polluted water from the Hudson and East rivers which reaches the Narrows after four or five hours does not produce a sudden reduction in the oxygen at the Narrows, as might be expected. The oxygen at the Narrows diminishes gradually throughout the ebb current, the effect of the flow from the Hudson and East rivers being imperceptible.

Rates of Change with Tidal Changes. The changes in the amount of oxygen which accompany changes in the tidal currents differ in rate and extent in different parts of the harbor, as illustrated by Fig. 13. In general, the greatest and most rapid changes take place in the outermost parts of the harbor. In the polluted parts of the harbor the changes are least.

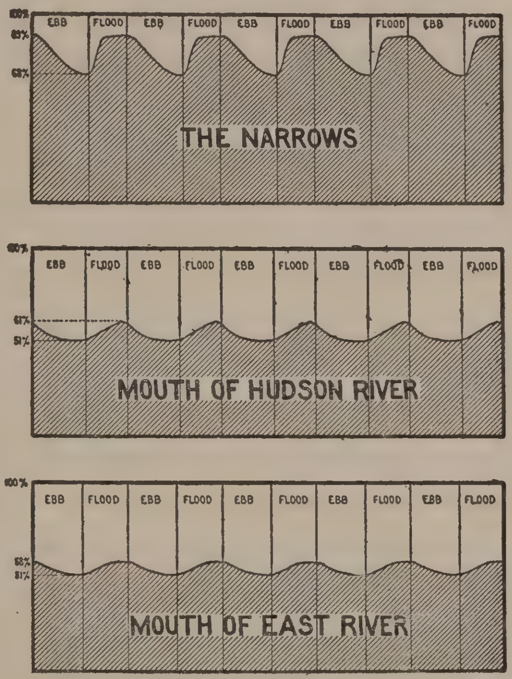

FIG. 13

Changes in Dissolved Oxygen which Accompanied Changes in Tidal Currents. The Number of Analyses included is 300

The greatest changes which occur in the amount of oxygen present at any point generally occur at the surface. The changes in oxygen which occur at the three principal entrances of the harbor (ocean, sound and Hudson) are the greatest which take place in any of the main channels.

The following data express the ranges in per cent. of saturation which occurred during a single tidal cycle at various points:

Narrows	20 per cent.
East river at Throgs Neck	18 per cent.
Hudson river at Mt. St. Vincent	16 per cent.
Hudson river at mouth	11 per cent.
East river at mouth	10 per cent.
Kill van Kull	10 per cent.
East river at Lawrence Point	10 per cent.
Lower end of Newark bay in the channel	10 per cent.
Lower end of Newark bay west of channel	15 per cent.

Relation Between Oxygen and Salinity. As a general thing, changes which take place in the salinity of the water at different tides are not accompanied by equal changes in the oxygen. At the Narrows, where some resemblance exists between the two, the range in oxygen is over twice the range in salinity. In most localities the salinity varies with the depth and the oxygen with the distance from shore.

Surface, Mid-depth and Bottom Compared. There is usually the same amount of oxygen at the bottom and at mid-depth, but the oxygen is often 5 per cent., and sometimes 10 per cent., less at the surface than at mid-depth. The oxygen seldom varies more than 5 per cent. of saturation between opposite shores, conditions in slips excluded.

The oxygen studies neither show the rate at which oxygen is being subtracted from the water by the accumulations on the harbor bottom nor the extent to which it is being added to the water from the atmosphere.

Samples were almost always taken at three depths—surface, mid-stream and bottom. The results of analyses, when reported by the analyst, were turned over to a draughtsman who plotted on a map the points from which the samples had been taken. Each point was indicated by a small circle. The results of the analyses were shown by writing alongside of the circles the percentage of oxygen present.

General Results in 1909 Work. An examination of a map made in this way, (see Plate E, p. 343; also Fig. 14, p. 57) indicates that the water of the Hudson river, opposite Manhattan Island, usually contained, in the summer of 1909, from 50 to 65 per cent. of saturation of oxygen. The water of the Lower East river and Upper bay was in about the same condition. The average for the Kill van Kull was much like that for the Upper bay, although in some cases there was over 80 per cent. of saturation. From 60 to 80 per cent. of saturation occurred in Newark bay. The Passaic river had from 40 per cent. to no oxygen in it. At Throgs Neck there was 80 per cent. or more of oxygen. At the Narrows there was upward of 60 per cent. In the Arthur Kill the oxygen was generally about half gone. In such samples as were taken in Jamaica bay the oxygen ranged from 0 to 50 per cent., although in some cases it was much higher. The samples were not thoroughly distributed through Jamaica bay, but were taken, for the most part, near sewer outfalls. The results of the 1909 analyses of surface samples are summarized on Fig. 14.

The work done in 1909 was divided into two parts: The first covered dry weather conditions of summer and the second part the early fall.

Summer Conditions in 1909 *and* 1911 *Compared.* In order to compare the summer conditions in 1909 with those of a similar period in 1911, the dissolved oxygen results between June 21 and July 26, 1909, so far as they related to the waters above the Narrows, were plotted on a map (Plate F, p 343). If more than one analysis was made at one point, the average of the results was taken, irrespective of depth or the direction of the current. The result of this average was plotted alongside of the point where the sample was located on the map. Arrows and small numerals showed how many samples were taken, and on what currents, at each spot. The data collected between June 27 and July 28, 1911, in the same territory, were worked up in the same way and plotted, for purposes of comparison. (Plate G, p. 419).

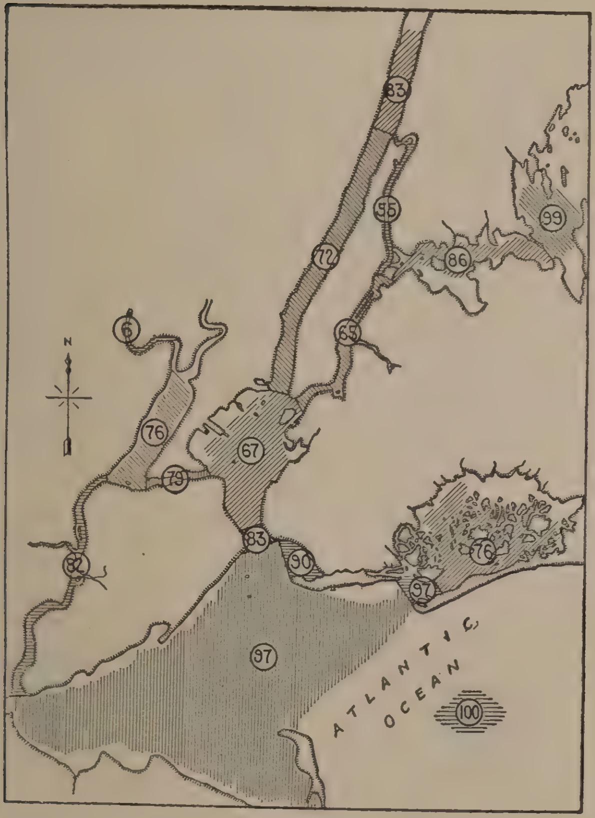

FIG. 14

Dissolved Oxygen Percentages in 1909 as Shown by the Analysis of Surface Samples. The Number of Analyses included is 289

Referring to Fig. 14 showing the results in 1909, it appears that the proportion of oxygen was about the same in the Hudson as in the Lower East river, except in the northern part of the Hudson opposite and above Manhattan, where the percentage of oxygen was greater than was found elsewhere. The average for the Lower Hudson and Lower East rivers appears, from an inspection of the maps, to have been about 65 per cent. Over 80 and even above 90 per cent. was not uncommonly found in the waters of the Lower Hudson north of Grant's Tomb. The water of Upper New York bay contained from 60 to over 80 per cent. Figures in the Kill van Kull ranged between about 64 and 95 per cent. In Newark bay, the percentage of saturation varied between 77 and 91 per cent. Over 95 per cent. occurred at Throgs Neck, the Sound entrance of the harbor.

A close comparison should not be made between the results obtained in 1909 and those found in 1911. The samples were not taken from the same points nor were they sufficiently distributed in 1911 to enable an exact idea of the condition of the water in the Upper bay between June 27th and July 28th to be obtained. Samples collected at the mouth of the Hudson and East rivers in 1911 averaged about 56 per cent. The water of the Hudson above Grant's Tomb seldom contained 80 per cent. The water of the Kill van Kull held much less oxygen than was present two years before. At Throgs Neck the average was 77 per cent. It appears that the water of the harbor was not in as good condition in 1911 as it had been in 1909, so far as the month of July was concerned.

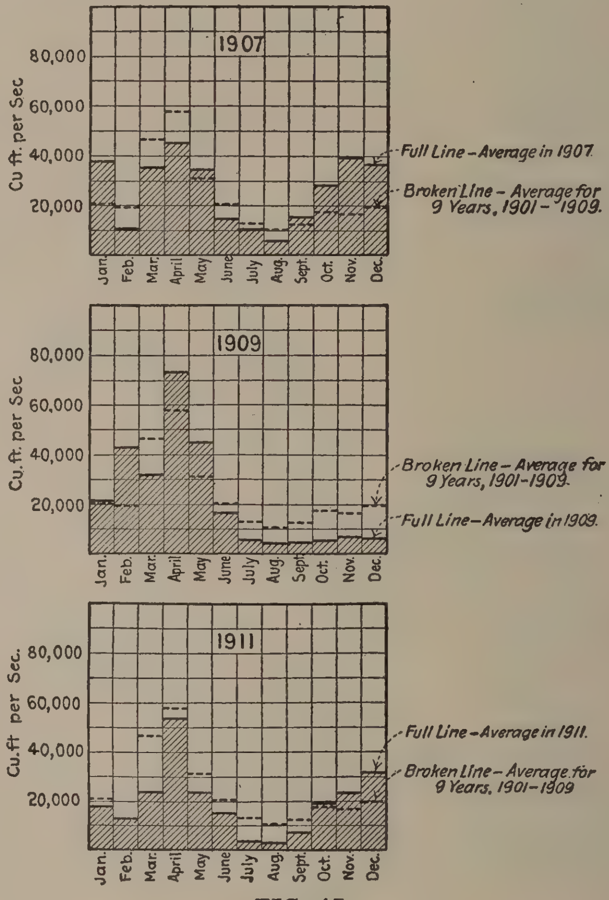

FIG. 15

Discharge of Land Water at the Mouth of the Hudson River. Calculated from Gaugings of the Hudson River at Mechanicville, and of the Mohawk at Dunsbach Ferry, with an equal pro rata Allowance for the rest of the Drainage Area of the Hudson

In order to ascertain whether there was a material difference in the quantity of water discharged by the Hudson in the years 1909 and 1911, figures showing the run-off of the Hudson were obtained from the New York State Engineer and Surveyor. The records thus secured related to gauge stations on the Hudson and Mohawk rivers above the confluence of those streams and about 150 miles from the river's mouth. About 59 per cent. of the whole Hudson river basin was included in this gauge. A computation was then made of the quantity of water discharged at the mouth of the Hudson, assuming that the discharge per square mile of the total drainage area was the same for the Lower Hudson as gaugings had shown it to be for the Upper Hudson and Mohawk. These calculations proved that the Hudson river was discharging slightly less water in 1911 than in 1909, as shown on Fig. 15.

During the summer months in 1909, the per cent. of oxygen ranged in the neighborhood of 58 on ebb currents, and from 60 to 70 on the flood currents, at the mouths of the Hudson and East rivers. At the Narrows, the per cent. of oxygen on the outgoing currents ranged from 72 to 81, and on the incoming currents it was in the neighborhood of 96 per cent. At Throgs Neck the oxygen on the outgoing currents varied between 87 and 97 per cent., and on the incoming currents it was often 100 per cent. In Upper New York bay outgoing currents contained between 54 and 73 per cent.; incoming currents between 63 and 75 per cent.

In the summer months of 1911 the oxygen was considerably less on both outgoing and incoming currents wherever observed. At the mouths of the Hudson and East rivers the outgoing current contained from 50 to 60 per cent. of oxygen, and the incoming current from 55 to 60 per cent. of oxygen. At the Narrows the outgoing current contained 65 per cent. and the incoming current 83 per cent. of oxygen. Incoming currents in the Kill van Kull contained from 62 to 66 per cent. In Upper New York bay outgoing currents contained from 60 to 65 per cent. and incoming currents from 61 to 70 per cent. At Throgs Neck, outgoing currents contained 71 per cent. and incoming currents 84 per cent. In the Hudson, opposite Mt. St. Vincent, about 2½ miles north of Manhattan Island, the incoming currents ranged from 64 to 72 per cent. and the outgoing currents from 66 to 83 per cent.

Averages of Surface Samples. Calculations were made to show the average amount of dissolved oxygen in the water at the surface in various parts of the harbor in the summer of 1911. There were 289 samples considered in arriving at these figures. In calculating the averages the following plan was followed. First, all samples taken at the surface on an ebb current at one point were averaged. Next, the averages for each of these several points of collection were averaged to obtain the average for the whole locality for ebb currents. In a similar way the average for the whole locality for flood currents was calculated. The mean of the averages for flood and ebb currents was finally taken as representing the average condition of the water, irrespective of currents, in the locality under consideration. In this manner the following figures were obtained:

Lower New York bay	98 per cent.
Narrows	73 per cent.
Upper New York bay	63 per cent.
Kill van Kull	66 per cent.
Newark bay (ebb current only)	54 per cent.
Upper East river	71 per cent.
Lower East river	55 per cent.
Hudson river to the north end of Manhattan Island	64 per cent.
Hudson river a few miles above Manhattan Island	81 per cent.
Long Island Sound north of Throgs Neck	96 per cent.
Harlem river	42 per cent.

Examinations of Cross-sections. A large part of the work done in 1911 was in the examination of cross-sections of the main tidal channels. A total of 1835 samples was collected at about 180 locations in and near New York harbor. Special attention was given to variations which occurred in the percentage of oxygen at various places at different stages of tide. Samples were invariably collected at the surface and at different depths at each point. In some cases over 100 samples were taken at a single cross-section in one day. There were about ten sections examined. The averages of all analyses of samples taken in cross-sections are shown by Figs. 16 and 17.

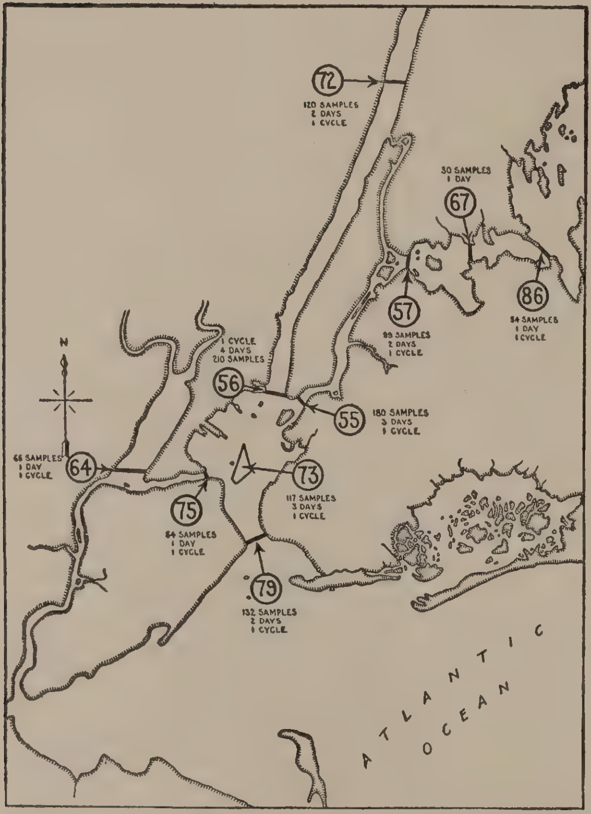

FIG. 16

Dissolved Oxygen Percentages in 1911 in Cross-sections of New York Harbor Averaged for all Depths and Tides. The Total Number of Analyses included is 1062

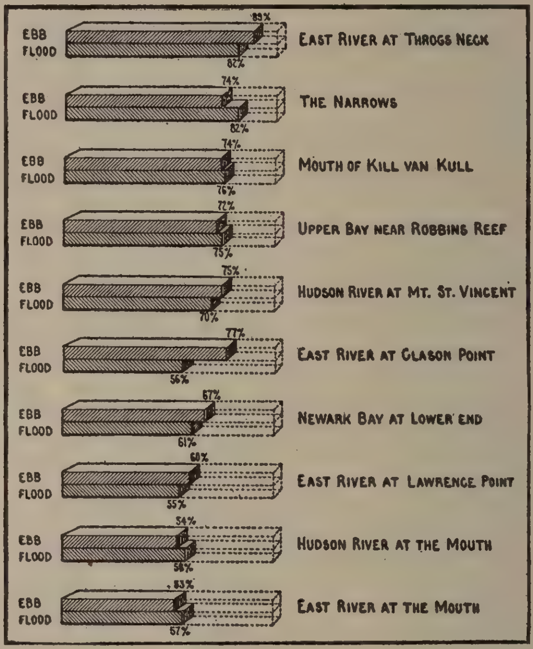

FIG. 17

Dissolved Oxygen Percentages in 1911 in Cross-sections of New York Harbor Averaged for Ebb and Flood Currents. The Total Number of Analyses included is 1062

Much of the data collected in the examination of cross-sections of the main tidal channels was plotted in the form of diagrams. These diagrams indicate the amount of oxygen at each sampling point in the cross-section and at each hour of the tidal cycle. There were usually fifteen sampling points in each cross-section. In connection with these studies of oxygen in cross-sections, careful account was taken of the changing salinity of the water and diagrams were made to show the salinity at the points and times when the oxygen was determined.

Work Done in Boston Harbor. During the course of the oxygen work done in 1911, it became desirable to obtain knowledge of the distribution of oxygen in the harbor of Boston. The sewage of Boston and many towns in its vicinity is collected by a system of main drainage and discharged at three principal points remote from the closely built-up shores of the harbor. Information as to the amount of oxygen in Boston harbor was not available at this time. On August 17th the Commission sent its launch and analyst to Boston by way of Long Island Sound. About 100 samples were taken at 36 locations between New York and Boston. The stay at Boston lasted from August 21st to September 18th. The number of samples collected and analyzed in Boston harbor was 401; they were collected from about 40 different points. The points included the water-front of the inner harbor and especially the neighborhood of the three sewer outfalls.

CHAPTER VIII

INTENSITY OF POLLUTION AS SHOWN BY ANALYSES FOR BACTERIA AND BY EXAMINATIONS OF DREDGINGS

Bacterial Content of the Harbor Water. The average numbers of bacteria in the water during ebb and during flood tides were determined for the period from March 26 to October 5, 1909, in the various sections of New York harbor, the number of analyses being 1,091. The average numbers at surface and at bottom during the same period in the various sections were determined from 835 of these analyses. The approximate locations of the points at which the samples of water were taken are shown on Fig. 18. On Plate D, opp. p. 265, are shown the averages of all samples taken at each location above the Narrows.

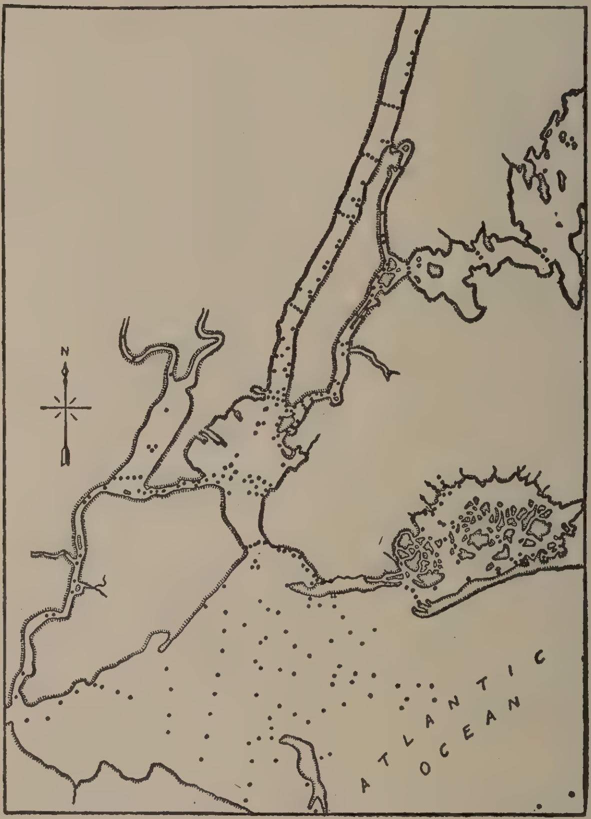

FIG. 18
Locations of Points from which Samples of Water were taken for Bacterial Analysis

In the Upper bay the average number of bacteria during the ebb tide was 13,800. During the flood tide there were 9,300 per cubic centimeter. The average number at the surface was 14,600; at the bottom there were 10,300 per cubic centimeter. The average number at all tides and at all depths was 12,500 per cubic centimeter.

In the Hudson river, from its mouth to Spuyten Duyvil, the average number of bacteria during ebb tide was 8,100, and during flood tide 5,100 per cubic centimeter. The average number for all tides and depths was 6,600 per cubic centimeter.

In the Hudson river, from Spuyten Duyvil to the upper end of Yonkers, the average number of bacteria during ebb tide was 5,200. During flood tide there were 4,700 per cubic centimeter. The average number at the surface was 6,300 and at the bottom 4,400 per cubic centimeter. The average number for all tides and all depths was 5,100 per cubic centimeter.

In the East river, from the mouth to Hell Gate, the average number of bacteria during ebb tide was 6,700. During flood tide there were 5,600 per cubic centimeter. The average number at the surface was 7,700 and at the bottom 4,500 per cubic centimeter. The average number for all tides and all depths was 6,100 per cubic centimeter.

In the East river, from Hell Gate to the entrance of Long Island Sound at Throgs Neck, the average number of bacteria during ebb tide was 1,800. During flood tide there were 4,200 per cubic centimeter. During flood tide the current in this section of the harbor is assumed to run toward Long Island Sound and during ebb tide from the Sound toward Hell Gate. The average number of bacteria at the surface was 3,300 and at the bottom 2,400 per cubic centimeter. The average number for all tides and all depths was 3,100 per cubic centimeter.

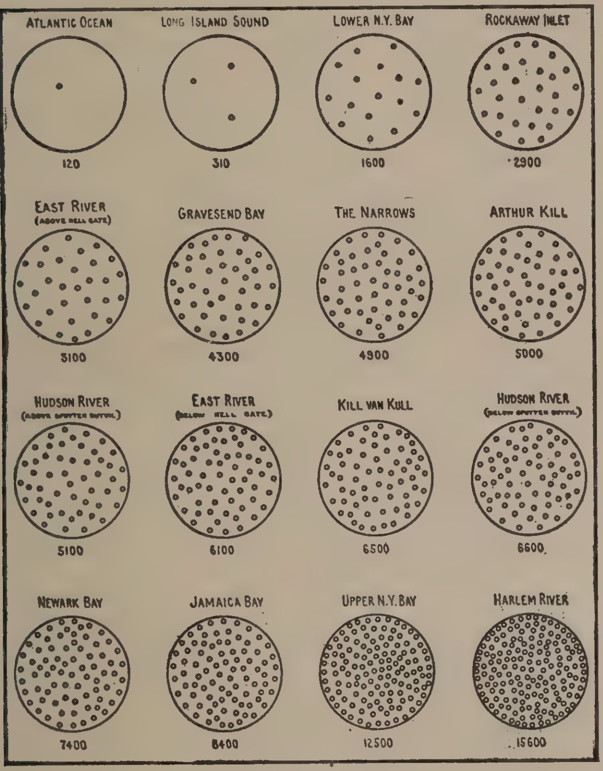

FIG. 19

Relative Bacterial Pollution of the Water in Various Parts of New York Harbor. This Diagram is Based on 1127 Analyses

In Long Island Sound the average number of bacteria during ebb tide was 390. During flood tide the number was 250 per cubic centimeter. The average number at the surface was 410 and at the bottom 190 per cubic centimeter. The average number for all depths and all tides was 310 per cubic centimeter. These averages were based on a series of samples taken about every six miles from Orient Point to Throgs Neck.

In the Harlem river the average number of bacteria during ebb tide was 16,200. During flood tide there were 15,000 per cubic centimeter. During ebb tide the currents in the Harlem river were from the East river toward the Hudson river, and during flood tide from the Hudson river toward the East river. The average number at the surface was 22,800 and at the bottom 8,000 per cubic centimeter. The average number for all tides and all depths was 15,600 per cubic centimeter.

In the Arthur Kill the average number of bacteria during ebb tide was 7,300, and during flood tide, after the comparatively unpolluted water from Raritan bay had entered the Kill, 350 per cubic centimeter. The average number at the surface was 5,500 and at the bottom 4,400 per cubic centimeter. The average number for all tides and all depths was 5,000 per cubic centimeter.

The relative bacterial condition of the water in various parts of the harbor is shown graphically by Fig. 19.

Bacterial Pollution Greater at Surface than at Bottom. The belief, founded largely on the oxygen analyses, that the waters of the harbor are well mixed from top to bottom appears to be contradicted by the Commission's analyses for numbers of bacteria. It has repeatedly been found that there were more bacteria on the surface of the water than in the depths below. The difference is usually not great but it is noteworthy. It is not easy to understand why the bacteria are relatively so numerous near the surface if the water is in an active circulation.

The explanation seems to be that the water at the surface continually receives large quantities of bacteria whereas the water below receives its bacteria chiefly from the water above it. The surface of the water doubtless receives bacteria from the air and from refuse which is swept overboard from ships and docks. At the surface of the water there is a considerable amount of solid, floating material which is in a more or less advanced stage of decomposition. Some of this material has come from the sewers, some has been swept overboard from vessels and lost from the piers and barges of the Street Cleaning Department.

Analyses of Dredgings Made Prior to 1908. Prior to 1908 bacterial and chemical analyses had been made of deposits on the bottom of New York harbor, but the information which these examinations furnished lacked definiteness as to the presence or absence of sewage matters. The work here described was undertaken in order to make this information more complete.

About 700 samples of solid matter were examined by the Metropolitan Sewerage Commission before 1908 for the number of bacteria which were contained, the results ranging from 7,500 to 26,000,000 bacteria per gram of dried material. In one case 400,000 bacteria were found in a sample close to another sample which contained 19,000,000. Comparing one section with another, the bacteria in the material at the harbor bottom were numerous in the Upper bay and in that section immediately west of the Brooklyn shore, and it is to be noted that they were usually most numerous where the pollution was most intense. But it was impossible to say how many bacteria would have been present in the absence of sewage matters.

Colon determinations to the number of 322 had been made of material from the bottom. In nearly all these cases this organism was found according to the presumptive test, but this test is not conclusive, nor is the presence of colon bacilli to be looked upon as certain proof of the presence of sewage. There had been 566 samples of solid matter in the harbor bottom analyzed for loss on ignition. This test did little to make it plain whether the deposits were composed of sewage matters. No examination had been made of mud from uncontaminated places.

Microscopical Examination of Dredgings. The Commission decided to confine its method of examination chiefly to the microscope. The procedure adopted consisted of two parts: (1) Observations of the color, odor and composition of the sample when collected; and (2) a search for débris which had probably come from sewage.

The locations of the points where samples were taken are shown by Figs. 20 and 21.

The microscopical examinations made, of which there were altogether 1,100, showed that a large part of the bottom of New York harbor was polluted with deposits of solid matter from sewage. The bottom of the Upper bay was generally polluted. Midstream in the Hudson and East rivers the bottom was fairly free from deposits containing sewage solids and was generally so hard that the samples could be obtained only with difficulty. The Lower bay was polluted in the principal ship channels. Foul deposits were found in the Kill van Kull and in the Newark bay, especially near Elizabethport and Newark. The deepest were found at the pierhead line off Elizabethport, Port Richmond, Hoboken and at the mouth of Gowanus Canal. Plates A, B and C, p. 223, show the results of examinations of solid matter from the harbor bottom.

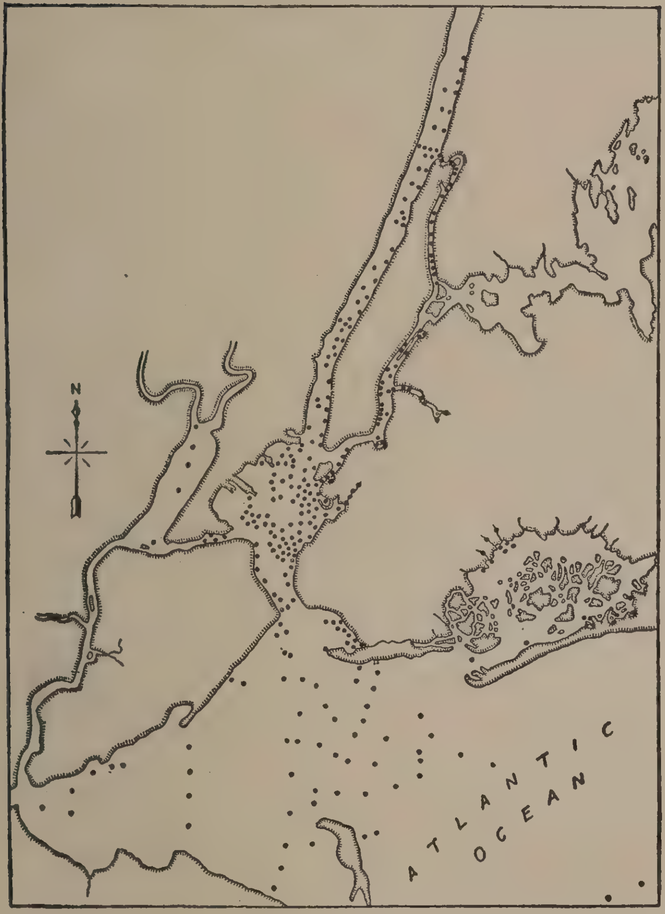

FIG. 20

Locations where Samples were taken for Bacterial Analysis of Dredgings from the Bottom of New York Harbor

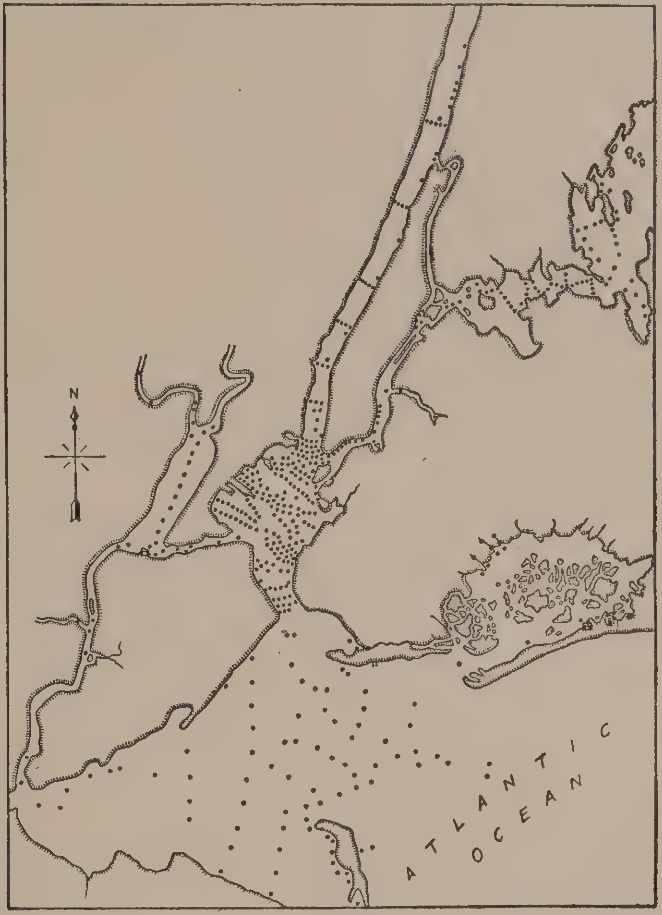

FIG. 21

Locations of Points from which Samples of Dredgings were taken from the Bottom of New York Harbor for Microscopic Analysis

PART II

The Degree of Cleanness which is Necessary and Sufficient for the Water

PART II

The Degree of Cleanness which is Necessary and Sufficient for the Water

CHAPTER I

OPINION OF THE COMMISSION AS TO THE DEGREE OF CLEANNESS SUITABLE FOR THE WATERS

To arrive at a decision as to the degree of cleanness suitable for the waters of New York harbor, it is necessary to consider what is required on the score of public health and decency. Risk of disease is of paramount importance, but it is not the only consideration.

At the outset it must be understood that to improve the present polluted condition of the harbor public works will be required. Were it not for the expense involved, practically all the sewage which is produced in the cities bordering on the harbor, could be carried to some distant point and there be purified or applied to agriculture or discharged into the sea.

Were the harbor as clean as it could be made, it is doubtful if the water would be employed otherwise than as at present. The danger of accidental and direct pollution would make the taking of shellfish for food unsafe within the harbor limits. The benefit of bathing without danger of contracting disease can be obtained by the establishment of bathing pools supplied with clean water and by suitably protecting the sea beaches.

The harm done by excessive pollution of the harbor water is indisputable. Although experts differ with respect to the amount of sickness which is produced by sewage contaminated water, the Commission considers that there is considerable danger in coming in contact with it, whether through bathing, fishing, the eating of shellfish or otherwise. Water which is black, greasy and effervescing with sewage, and in which plainly recognizable ingredients of sewage exist should not be tolerated in any part of the harbor.

It is evident from the studies made by the Commission that large quantities of sewage can be assimilated by the waters of the harbor without risk of creating offensive conditions, and if the dangers which lie in bacterial impurities be disregarded, it will be possible to discharge large quantities of sewage from which the most objectionable matters have been removed, into these waters without injury and without excessive cost for public works. The Commission considers that in many parts of the city the construction of disposal works which make use of the principles of screening and sedimentation in combination with outlets which will secure a prompt diffusion of the treated sewage in the water, is the remedy now required, and that these works should be so built as to form part of a more extensive and composite plan for the exclusion of sewage from the harbor if greater protection should be needed in the future.

Upon the matter of the jurisdiction which should be exercised over the harbor, the Commission in its report of April 30, 1910, expressed the opinion, which it now reiterates, that it would be desirable to establish by acts of the Legislatures of the States of New York and New Jersey, an interstate sewerage commission to protect the harbor waters. If this interstate action cannot be brought about, then the conservation of the harbor waters of the Metropolitan District of New York should be undertaken by a New York Commission.

With regard to the degree of cleanness that should be maintained in the harbor waters, the Commission is of opinion that no single standard, such as the amount of dissolved oxygen present, would be practicable. As a result of much thought, many investigations and the best expert advice procurable, the Commission has adopted for its guidance the general standards of requirements stated below:

1. Garbage, offal or solid matter recognizable as of sewage origin shall not be visible in any of the harbor waters.

2. Marked discolorization or turbidity, due to sewage or trade wastes, effervescence, oily sleek, odor or deposits shall not occur except perhaps in the immediate vicinity of sewer outfalls, and then only to such an extent and in such places as may be permitted by the authority having jurisdiction over the sanitary condition of the harbor.

3. The discharge of sewage shall not materially contribute to the formation of deposits injurious to navigation.

4. Except in the immediate vicinity of docks and piers and sewer outfalls, the dissolved oxygen in the water shall not fall below 3.0 cubic centimeters per litre of water.* Near docks and piers there should always be sufficient oxygen in the water to prevent nuisance from odors.

5. The quality of the water at points suitable for bathing and oyster culture should conform substantially as to bacterial purity to a drinking water standard. It is not practicable to maintain so high a standard in any part of the harbor north of the Narrows, or in the Arthur Kill. In the Lower bay and elsewhere bathing and the taking of shellfish cannot be considered free from danger of disease within a mile of a sewer outfall.

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*With 60 per cent. of sea water and 40 per cent. of land water and at the extreme summer temperature of 80 degrees F., 3.0 cubic centimeters of oxygen per litre corresponds to 58 per cent. of saturation.

CHAPTER II

SUMMARY OF OPINIONS OF VARIOUS EXPERTS CONSULTED BY THE COMMISSION WITH RESPECT TO STANDARDS OF CLEANNESS FOR THE HARBOR

In the summer of 1911, the Commission requested a number of sanitary experts to express opinions as to the degree of cleanness which was necessary and sufficient for the waters of New York harbor.

The experts were selected from the professions of civil engineering, chemistry, biology and sanitary science. Each expert was given a list of questions to which he was asked to make reply.

The experts were afforded facilities to inspect the harbor in order to become personally acquainted with the conditions created by the present method of disposing of sewage and with the uses to which the harbor waters were put, and were furnished with the printed reports of the Commission. Following is a list of the persons employed:

The Experts

W. E. Adeney, D.Sc., F.I.C., formerly Curator and ex-Examiner in Chemistry of the Royal University, Dublin. Professor Adeney is one of the most eminent living authorities on the chemistry of sewage-polluted tidal waters. With Prof. Edmund A. Letts, he is the author of an exhaustive monograph on the digestion of sewage by harbor water, published as Appendix VI of the Fifth Report of the Royal Commission on Sewage Disposal of Great Britain.

Charles V. Chapin, M.D., Health Officer of Providence, R. I. Dr. Chapin is an authority on the transmission of communicable diseases. He is the author of well-known books of reference on Municipal Sanitation in the United States and Modes and Channels of Infection.

Harrison P. Eddy, B.S., Member of the American Society of Civil Engineers, Consulting Engineer, Boston, Mass. Mr. Eddy has had much practical experience in the design, construction and management of sewerage and sewage disposal works for large cities.

Desmond Fitzgerald, C.E., Past President of the American Society of Civil Engineers, Consulting Engineer, Boston, Mass. Mr. Fitzgerald has had wide experience in engineering and has been connected with sanitation work in Boston, Chicago, Manila and many other cities. He has made a special study of harbors in Europe and America.

William P. Mason, C.E., M.D. Dr. Mason is Professor of Chemistry in the Rensselaer Polytechnic Institute of Troy, N. Y. He is an eminent sanitarian and the author of various treatises on sanitary subjects.

William T. Sedgwick, Ph.D., Professor of Biology in the Massachusetts Institute of Technology, Boston, Mass. Professor Sedgwick is a prominent sanitarian. He is the author of a treatise on Principles of Sanitary Science and the Public Health.

F. Herbert Snow, C.E., Member of the American Society of Civil Engineers, Chief Engineer of the Pennsylvania State Department of Health. Mr. Snow has had wide experience in the sanitary disposal of sewage.

C.-E. A. Winslow, B.S., M.A., Assistant Professor in the College of the City of New York and Curator of Public Health of the American Museum of Natural History. Professor Winslow has had much experience in sanitary investigations, particularly with reference to the purification of sewage.

The Questions. The questions submitted to the experts were intended to elicit opinions concerning the degree of cleanness suitable for the harbor and on what considerations a standard of cleanness should be established. The questions follow:

"1. Do you think it would be desirable and feasible to establish a standard of cleanness for the waters of New York harbor?

"2. If a standard is established, should it be based solely on chemical analyses or would a mixed standard which would take into consideration the appearance of the water and perhaps its physical, chemical and bacterial condition be better?

"3. Should a standard of cleanness rest upon the amount of sickness and death which can be shown to be produced by pollution or should the standard be based on what seems suitable and appropriate on the score of cleanness?

"4. Should the waters be kept pure enough for bathing and, if so, where?

"5. Should the waters be kept pure enough for oyster culture and, if so, in what parts of the harbor?

"6. Should effervescence, marked discoloration, decided turbidity, oily sleek, floating solid sewage materials or deposits of sludge be permitted anywhere in the harbor and, if so, where and under what circumstances?

"7. Should we establish one standard of cleanness for the whole harbor, or should there be different standards for different parts of the metropolitan district?

"8. If a definite standard of cleanness is desirable, how should that standard be expressed? Please give us a draft of your opinion as to the proper wording?

"9. Will the amount of dissolved oxygen in the waters of the harbor, expressed in a percentage of its saturation value, furnish a reliable index of the cleanness of the water and, if so, what percentage should be adopted to secure each of the following results:

> "(a) That the waters of the harbor may not become offensive under any weather conditions.
>
> "(b) That the use of public baths, if judiciously located, may not be prejudicial to the health of those using them.
>
> "(c) That shellfish taken from the beds in present use may be eaten without danger to health.

If the percentage of dissolved oxygen will not furnish a satisfactory standard, what standard would you suggest, and should it be based upon chemical analysis, or should it take into account chemical, physical and bacterial conditions?"

Replies to the Questions. All the experts considered that it would be both desirable and feasible to establish provisional standards of cleanness for the harbor. Some were in favor of one standard while others favored a number of standards. Dr. Adeney, Professor Sedgwick and Mr. Eddy preferred to consider such standards as may be required in the light of restrictions against pollution rather than as degrees of purity. There was remarkable unanimity of opinion as to the importance of providing for a suitable state of cleanness apart from what was necessary simply on the score of health.

Only Professor Adeney would base a standard solely on chemical analyses. The best and simplest chemical analysis was considered to be the amount of dissolved oxygen in the water, but no one was willing to accept this test as an all-sufficient criterion of the condition of the water. As Mr. Eddy expressed it, a standard based solely on the dissolved oxygen might prove satisfactory with respect to offensive odors, but it would give no indication of the existence of offensive floating matters or throw much light upon the danger to health from bathing and from eating shellfish. Professor Winslow considered that the oxygen should be regarded as a reliable index of the cleanness of the water only when dealing with conditions of gross pollution, and only then in conjunction with observations of the appearance and physical condition of the water. Professor Adeney thought it would be desirable to take account of the ammoniacal nitrogen as well as the dissolved oxygen.

Mr. Fitzgerald and Professor Mason advised a mixed standard which gave prominence to the physical condition of the water. Mr. Snow would not have a standard of cleanness based solely upon analyses of any kind. The experts were all of opinion that the standard of cleanness should not rest solely upon the effect of the polluted waters upon health. All laid great emphasis upon the necessity for regulations which would keep the waters in a suitable condition on the score of cleanness. In their opinion the sewage of the metropolitan district should be disposed of in such ways as not to offend the sense of decency nor depreciate the value of shore property, nor interfere with the use of the water for bathing where it was fitting that bathing should occur. Professor Sedgwick thought that bathing could never be wholly discontinued in the populous parts of the harbor and that the water should be kept clean enough to make bathing reasonably safe.

So far as sickness is concerned, it was Dr. Chapin's opinion that the present condition of the harbor was not a serious menace to health; but that was no reason why sewage should be permitted to defile the water. Strong reasons existed for keeping the harbor clean. There was a public demand for clean highways and clean waterways as well. To the occasional visitor to New York, it appeared that the limit of permissible pollution of its waterways had been reached. The waters were evidently heavily polluted with sewage.

Professor Mason considered that the amount of disease and death directly produced would not be a proper measure of the objectionable nature of the harbor's condition. Conditions which offended the senses, and of the existence of which he saw abundant evidence, should also be taken carefully into account, for such conditions indirectly lead to disease.

Mr. Fitzgerald pointed out that while many lives probably could be saved and much ill health alleviated by reducing the pollution, it was still more important to consider the question of a clean harbor from the standpoint of what was suitable and appropriate on the score of cleanness. It was a case where civilization demanded a remedy on the score of what was necessary for the comfort, happiness and welfare of the public.

Bathing and Shellfish. There was a preponderance of opinion among the experts that it would not be practicable to keep the waters of the inner harbor clean enough to make bathing entirely safe, but it was held to be both feasible and desirable to maintain bathing places near the sea, and within easy reach by the public, in satisfactory condition. Because some bathing was likely to occur in the populous parts of the harbor in spite of any restrictions which might be made, and because the shores were certain to be crowded with human beings engaged in gainful occupations or seeking the water-fronts for relaxation and fresh air, Professor Sedgwick and others thought the water along the shore ought to be kept as clean as practicable.

In Mr. Eddy's opinion, it seemed probable that if the open waters of the harbor were maintained as clean as the requirements of business, pleasure and recreation demanded, there would be little danger to the public health, provided bathing and the taking of shellfish for food were restricted or prohibited. Dr. Adeney did not think there was great danger in bathing, provided analyses showed that the water contained plenty of oxygen, was comparatively free from ammonia and there was absence of visible sewage matters. Dr. Chapin did not consider that there was great danger of sickness from bathing in polluted water, provided the sewage was discharged at a considerable distance from the bathing places. On the other hand, Mr. Eddy found it impossible to avoid the conclusion that considerable sickness was produced by bathing in the polluted harbor of New York. All thought it unnecessary that the waters of the inner harbor should be kept pure enough for bathing, if suitable bathing places, such as Coney Island and Rockaway, could be maintained in satisfactory condition. Professor Sedgwick would have such bathing places as Coney Island kept in scrupulously clean condition. Mr. Fitzgerald did not think it practicable to make bathing in the waters of the inner harbor safe against disease, and regarded this as an unreasonably high standard of cleanness to seek to maintain. Dr. Mason considered that it would not be possible to keep the water in any part of Upper New York bay clean enough for bathing and thought that bathing establishments on the water front of Manhattan and Brooklyn were a menace to public health. The very presence of these places, Dr. Mason pointed out, was a guarantee by the City authorities of the safe character of the water. Professor Winslow expressed the opinion that the waters of the inner harbor should be abandoned for bathing and shellfish culture. The waters of the Lower bay could, he thought, be kept clean enough for bathing and the cultivation of shellfish and should be maintained in that condition.

All the experts considered it impracticable to keep the waters in the inner part of New York harbor pure enough for oyster culture, but, with care, it seemed to some to be possible adequately to protect oyster grounds near the sea. The value of the oyster industry did not appear to Mr. Eddy to be of sufficient consequence to warrant the construction of the expensive works which would be necessary to insure to the waters of the inner harbor a sufficient degree of purity to warrant oysters being taken from them. Professor Sedgwick did not consider the oyster business to be of enough importance to require any special degree of purity for the waters. The danger of pollution from passing ships was so great as to forbid the culture of shellfish in New York harbor. Mr. Fitzgerald felt that shellfish should be protected against sewage in areas which were remote from centers of human activities, if this protection could be made genuinely effectual.

Mr. Snow would not permit oysters to be cultivated anywhere within the metropolitan district except under strict supervision and control, and Professor Winslow admitted that it might ultimately be necessary to sacrifice all oyster beds within the metropolitan district.

Visible Pollution. All the experts held the opinion that, while visible evidence of sewage was practically unavoidable near sewer outfalls, large sewage solids should not be present anywhere in the harbor except perhaps to a limited extent from the shipping. A small amount of oily sleek was permissible, but sludge and the escape of putrefying gases should be prevented. Dr. Adeney believed that sewage solids, either floating or deposited, should certainly not be permitted anywhere except from boats, but that some discoloration and turbidity might be allowed in the vicinity of suitably situated outfalls. Mr. Eddy considered that turbidity and discoloration might be tolerated over relatively small areas in the immediate vicinity of properly located sewer outfalls, and oily sleek be allowed, provided it consisted simply of very thin films of oil in isolated and relatively small areas. Mr. Fitzgerald would not permit sewage to be visible at the points of sewage outfall or elsewhere, and considered that the sewage should be purified or discharged into deep water under circumstances which would prevent its appearance from the shores, docks and other places where it might prove offensive. The water should not be allowed to become so polluted as to be blackened. Deposits of putrefying sludge should not be permitted to occur along the docks.

In Dr. Mason's opinion, the presence of oily sleek was not objectionable since he did not consider it unsightly and an infinitesimal amount of oily matter might produce it. He considered that it would be impossible to keep the water free from discoloration and turbidity, on account of the natural silt which the Hudson river carried down from the northern part of the state. Floating solid sewage material should not occur. Conditions which were disagreeable or disgusting either to the sight or smell of the average citizen using the waters for rowing, sailing or similar pleasure purposes, Professor Sedgwick thought, should not be permitted.

Mr. Snow felt that the visible evidences of sewage were so objectionable, and already existed to such an extent, that immediate steps should be taken to construct a system of main drainage and sewage disposal. This view was also held by Dr. Chapin and others. Mr. Fitzgerald expressed the opinion that no time should be lost in determining upon, and beginning, this work, so that the pollution of the harbor might be reduced rather than increased, a result which he considered inevitable if wise action was not soon begun.

Suitable Standards. Most of the experts favored the establishment of some standard of cleanness, or, better, a limit of pollution for the water. Two favored a single standard as the ultimate limit of impurity to be permitted anywhere. Another thought that the standard should rest not upon the quality of the water which was desirable, but upon the degree to which it was practicable to purify the sewage before discharging it into the water.

Mr. Eddy was of opinion that one standard for the whole harbor would be best. He believed that attempts to formulate different standards to meet the conditions in different portions of the harbor would lead to great complexity and would be of little practical value because of the constantly changing character of each locality. It seemed to him more practicable to fix upon a single standard which should represent the worst condition which was permissible at any point.

Professor Sedgwick would have various restrictions adopted which might be termed standards, although he thought they should be regarded as provisional and temporary and not rigid or inflexible. Mr. Fitzgerald thought it would be impossible to establish one standard of cleanness for all parts of the harbor, for in some places such a standard could never be attained. Different standards of cleanness for different regions would be better. Professor Winslow would have different standards for different parts of the harbor. His idea was that certain areas must necessarily be so polluted as to be unsuitable for bathing and shellfish and that these should be given over to the purposes of sewage digestion, subject to such proper regulation that offensive sights and smells should be avoided, while other regions should be maintained in a condition suitable for bathing and shellfish culture.

All agreed that suitable standards of cleanness for the harbor would take full account of the degree of purity necessary on the score of cleanness alone and provide against the presence of solid matters readily recognizable as of sewage origin, the existence of gas, the production of sludge and an excessive amount of turbidity produced by sewage.

So far as the permissible draught upon the oxygen was concerned, there was no unanimity of opinion. All who expressed themselves upon this point considered that a deficiency of 50 per cent. indicated serious conditions. Mr. Fitzgerald's idea was that the sewage should not reduce the percentage of dissolved oxygen anywhere below 50 per cent. In the neighborhood of permanent or comparatively permanent beds for the cultivation of shellfish, the standard should insure bacterial purity. In the vicinity of bathing places, the water should not only be of a high standard bacterially, but should also be free from floating garbage, should have a large amount of dissolved oxygen and should be chemically near the normal condition of pure salt water or water of the normal salinity due to its position. In the neighborhood of docks and thickly populated shores, it might be sufficient to provide a physical standard of purity.

Professor Mason was not prepared to suggest a definite amount of oxygen as the most suitable to seek to maintain, although he believed 70 per cent. was an unduly severe measure by which to be guided. He considered that the physical appearance of the water, more complete chemical analyses than determinations of dissolved oxygen and bacterial examinations should be included in the standard of cleanness.

For the more polluted parts of the harbor, Professor Winslow suggested that the dissolved oxygen should be at no time and at no place allowed to fall below 50 per cent. of its saturation value. No effervescence, marked discoloration, decided turbidity, oily sleek, floating solid sewage materials, deposits of sludge, or other conditions offensive to sight and smell, should be permitted in any part of the harbor. For the less polluted regions, the outer bay, for example, the standard should be primarily sanitary and should rest upon bacterial rather than chemical data.

In Mr. Eddy's opinion, the waters should not contain floating sewage matters which were readily recognizable as such. Grease, oil and tar should not be discharged in quantities sufficient to cause them to accumulate on beaches, sea-walls, piers and boats. The suspended matter of sewage should not be present to an extent which would be recognizable to persons in the parks, upon the recreation piers or upon the water itself, except in the immediate vicinity of sewer outfalls. It should not form sludge banks which would require dredging or, by the formation of gas would give to the waters the appearance of effervescence. Organic matter should not make such a demand upon the water as to exhaust the supply of dissolved oxygen to a point below 3 cubic centimeters per liter of water, at any place during any week in warm weather.

Dr. Adeney would establish a higher standard of purity than any of the experts mentioned, so far as oxygen was concerned. He would not permit the oxygen to be exhausted below 60 or 70 per cent. of saturation, at low tide under calm weather conditions and at any point within 200 yards of a point of sewage discharge, either at the surface or at any depth below it. Before discharge, the sewage should be freed, as far as possible, of solid matters by means of mechanical subsidence, or, in the case of unfavorably situated outfalls which it would be difficult or impossible to remove, by chemical precipitation. In Professor Adeney's opinion, such a requirement would insure proper protection to the harbor without undue hardship upon the taxpayers. The water beyond the neighborhood of the sewer outfalls would, in all probability, show no appreciable deficiency in dissolved oxygen, not even when the volume of sewage to be disposed of became largely increased with the increase of population.

A glance at the reports shows that all the experts thought the harbor should be kept in very clean condition. Strong language was used by men noted for conservatism, to express their sense of the unsuitability of allowing the present conditions of pollution to continue. The restrictions suggested were to prevent intolerable conditions, not to establish an ideal. The future was certain to be more exacting. Professor Sedgwick said in a letter accompanying his report:

> "I wish that it might be possible for your honorable Board to convince the people of Metropolitan New York, as I am convinced, that no investment, however great, would be too large to secure the complete and perpetual conservation of these waters for purposes of health, of pleasure and of agreeable and attractive commerce. Nor is this condition merely an iridescent dream. A sum such as is already set apart for clean, pure drinking water for the Metropolis would go far toward making this a reality; and I hope you will understand that while in answering your questions, I have tried to tell the truth as to the possibility of the disposal of the sewage into the adjacent waters without the creation of an intolerable nuisance, I am of opinion that any such disposal should be regarded as merely provisional and temporary; the ultimate solution of the problem before you being the complete and total removal of all sewage and other polluting materials from the harbor waters."

CHAPTER III

REPORTS OF THE EXPERTS CONSULTED BY THE COMMISSION WITH RESPECT TO STANDARDS OF CLEANNESS FOR THE HARBOR

SECTION 1.

REPORT OF W. E. ADENEY

I. METHOD EMPLOYED BY THE METROPOLITAN SEWERAGE COMMISSION OF NEW YORK FOR THE DETERMINATION OF DISSOLVED OXYGEN IN THE NEW YORK HARBOR WATERS.

The Metropolitan Sewerage Commission have adopted the ferrous sulphate method for the determination of dissolved oxygen in the waters of New York harbor; employing the form of apparatus devised by Professor Letts and Mr. Blake for use with the method; but introducing some important changes in the chemical re-agents required, whereby the manipulations involved in carrying out the method have been simplified, and the skill, time and labor required in making determinations of dissolved oxygen in tidal waters have been reduced to a minimum.

The changes referred to consist of the substitution of a solution of carbonate of soda for ammonia in the precipitation of the oxygen-absorbing ferrous compound, and the use of potassium permanganate instead of potassium bichromate for the necessary titrations, with attendant simplifications in manipulation.

The accuracy of the method, as carried out by the Commission, has been independently tested by a number of chemists in America against the absolute eudiometric method, and concordant results have been obtained by them.

The writer himself had opportunities of observing the method, as worked by the officers of the Commission, during his inspection of New York harbor in October, 1911; and he has formed the opinion that the method, as carried out by the Commission, yields accurate and reliable results.

Furthermore, owing to the extreme simplicity of the manipulations involved in the carrying out of the Commission's modification of the method, it can be operated in small boats in stormy weather, when it would be practically impossible to employ the modification of Letts and Blake, in which bichromate is used for titration, or any other method. For the same reason, a given observer could make by its means a greater number of determinations in a given time than by any other known method; a consideration of very great importance in carrying out extended investigations of tidal waters for the purpose of ascertaining their conditions as regards pollution.

II. The Rate of Re-aeration of Polluted Inshore Tidal Waters.

Amongst the known conditions, which affect the rate of re-aeration of large volumes of polluted inshore tidal waters, that is to say, of sea water mixed with polluted fresh water, there are three of fundamental importance—(1) the area of water exposed to the air; (2) the temperature of the water; and (3) the humidity of the atmosphere.

When the surface of a tidal water remains calm and unbroken, either by wind or by water currents, and when the atmosphere is calm and saturated with moisture, the rate of re-aeration will be practically at zero.

As these conditions change, re-aeration will begin to become appreciable, and the rate will reach the maximum when the surface of the water is broken to the maximum extent by the force of the wind and tidal currents, and when the temperature of the water and the humidity of the air are such as to cause a maximum evaporation from the exposed surface of the tidal water. *The rate of re-aeration must therefore be an extremely variable quantity from day to day, and even from hour to hour.*

The dependence of the rate of re-aeration upon the area of water exposed to the air is obvious, and the effect of the wind and tidal currents, in so far as they may tend to increase the area of exposed surface, and to cause a mixing of those waters which have been exposed to the atmosphere with the mass of water below the exposed surface, will also be readily recognized as factors of practical importance.

Circulating currents from the exposed surface downwards, arising from thermal changes, must also be included amongst the conditions which may affect the rate of re-aeration.

The effect of evaporation from the exposed surfaces of large volumes of inshore tidal waters has not hitherto been generally recognized. But as evaporation occurs, the layer of water exposed to the air becomes concentrated, and sinks, or "streams," to adopt the expression suggested by Huefner, downwards, and carries with it a charge of dissolved oxygen, and thereby effects the re-aeration of the water below the surface, when the dissolved oxygen therein has been exhausted by sewage pollution.

Colonel Black and Professor Phelps have however denied, in a recent report presented to the Board of Estimate and Apportionment upon the Discharge of Sewage into the New York harbor, that evaporation exercises any effect upon the re-aeration of inshore tidal waters.

They hold that the effects of evaporation may certainly be ignored in the case of inshore waters, since their surface layers are generally fresher, and therefore less dense than the deeper layers; and they have assumed, without, it may be added, any experimental evidence, that the rate of re-aeration of a quiescent body of polluted tidal water strictly follows Fick's law of diffusion.

Careful consideration of these two assumptions will serve to show, however, that neither has any real foundation in fact.

With regard to the first, it may be pointed out that liquid sewage matters are borne by fresh water, and that, consequently, when the physical conditions of a tidal water, into which such matters drain, are favorable to the accumulation of fresh waters along its surface layers, the liquid sewage matters will also gather there; and under these circumstances the heavy sea water below the fresher and lighter surface layers will remain practically unpolluted, unless its bed be polluted with solid sewage matters. Consequently, exhaustion of the dissolved oxygen in the tidal waters by the sewage matters will be limited to that contained in the surface layers. The question, therefore, of re-aeration need only be considered in reference to the surface layers, when the drainage of sewage matters into the tidal waters is under proper control, and their re-aeration will be effected in the various ways above enumerated, but chiefly by downward "streaming" from the exposed surface of air-saturated and relatively denser liquid, as above indicated.

The description by the writer of the estuary of the River Liffey, County Dublin, Ireland, which will be found in Appendix VI to the Fifth Report of the Royal Commission on Sewage Disposal, may be referred to as affording an excellent illustration of a tidal water, the physical circumstances of which favor an accumulation of fresh water, including liquid sewage matters, along its surface layers.

The phenomena of "streaming" will be fully considered later on.

With regard to the second of the above assumptions, the writer desires to point out that Messrs. Black and Phelps have made no experimental investigation whatever with sea water, and that they have no experimental evidence to advance in support of the statement, which they make on p. 52 of their Report, which runs as follows: "Therefore there is no apparent reason to believe that the re-aeration of salt water follows any other laws than those which we have determined mathematically and experimentally for fresh water."

Messrs. Black and Phelps have put forward a working formula for calculating the rate of re-aeration in fresh waters, which, as already stated, they regard as applicable to sea water, and which they state is expressed in terms of time, depth, the diffusion co-efficient, and the initial dissolved oxygen value. The diffusion co-efficient has been determined by a method and apparatus especially designed by them. But on turning to the description of the method given on p. 93, it will be found that the values resulting from its employment bear no resemblance, and no relationship, to the diffusion co-efficient of dissolved oxygen in water, and as determined by Huefner (Ann. Phys. Chem. II, Vol. 60, pp. 134-168).

Thus the water employed for an observation is boiled in a glass flask with "iron-excelsior," and it afterwards is retained in the flask over night. The water, therefore, even if distilled to start with, cannot be regarded as such, when it is exposed to the air for a diffusion co-efficient test, since it must by that time have dissolved appreciable quantities of mineral matter from the glass, and possibly also from the iron.

But the method is open to much more serious objection—the rubber stopper employed for closing the tube is made "wet with a very dilute caustic solution to assist the sliding" (p. 93). In this way a further quantity of soluble mineral matter is taken up by the water. This latter source of soluble matter must be regarded as serious, since the volume of water employed in the experiment is very small, not as much as 10 cc., especially when compared with the area of glass surface over which the rubber stopper after being wetted with the caustic solution has to be drawn.

Thus the water to be exposed to the air for the determination of the diffusion co-efficient of oxygen must be regarded as holding decided quantities of mineral matter in solution. Consequently, if any evaporation occurs, as it must freely do from the exposed surface of the water during the experiment, a denser layer of water will be formed over the exposed surface, with attendant downward "streaming" of dissolved oxygen, at a rate depending upon the temperature of the water bath, in which the experimental tube is kept, and the dryness of the air.

There can be no doubt, in the opinion of the writer, that this affords the explanation of the increased values which Black and Phelps have obtained, and which they have recorded on p. 44, for increasing temperatures of the water bath from 5° C. to 25° C.; they are as follows, expressed in per cent. of saturation:

5° C.	0.65
10° C.	0.75
15° C.	1.00
20° C.	1.42
25° C.	2.43

That the results obtained by these observers do not represent the true co-efficient of diffusion of oxygen in water becomes evident on carefully examining them.

Black and Phelps admit themselves that their results were attended with great uncertainty. They refer to them, on p. 94, thus: "the values are somewhat scattering, and a closer analysis indicates that some unknown factor is involved. Exceedingly concordant results are readily obtained upon one day, while upon the following day another group of concordant results will be obtained, differing from the first. Barometric corrections were later applied without relieving the situation."

After this admission by the observers themselves, it is unnecessary further to labor the point that the values adopted by them for the diffusion co-efficient of dissolved oxygen in water have been arbitrarily selected, and have no resemblance nor relationship to the true co-efficient of diffusion of oxygen in water; and that, consequently, their proposed formula for calculating the rate of re-aeration of large volumes of polluted tidal water is valueless, and must lead to seriously misleading results.

To return to the consideration of the phenomena of "streaming," the writer has found, as a result of a considerable number of direct experiments on the rate of re-aeration of sea and of fresh waters with 6-foot columns of de-aerated sea water, and of de-aerated distilled water, that the rate of re-aeration of polluted tidal waters may be affected by two forms of downward transmission, or "streaming," of dissolved oxygen from the exposed surface, which in magnitude far surpass that due to true diffusion according to Fick's law, and which, or one of which at least, may exercise an influence sufficient in magnitude to be of importance in connection with the practical question of the protection of tidal waters from over-pollution by sewage matters.

The term "streaming" may be applied to these forms of downward transmission of dissolved air, to distinguish them from the transmission caused by true diffusion.

It is not difficult experimentally to determine the behavior and magnitude of these two forms of "streaming" under a particular set of conditions in the laboratory.

Thus, for each of the following experiments, except the first two, three tubes, each 6 feet long and 0.75-inch bore, were filled with de-aerated sea water; the tubes were closed each with a cork fitted with an inlet and outlet tube, and were connected together in series so as to allow the same current of air to be drawn continuously through the surface layer, down to a depth of 2 to 8 inches, of first one tube, then another and finally the third.

Similar experiments were made with distilled water.

During an experiment the tubes were placed in a cold water jacket, so that their contents from the bottom to about a foot from the top could be kept at distinctly lower temperatures than the surface layers. This was done to prevent the formation of convection currents in the experimental columns of water.

EXPERIMENTS WITH SEA WATER.

No.	Duration of Experiment	Temp. C.	Degree of Aeration, in Percentages of Saturation								
			Uppermost Layer			Middle Layer			Bottommost Layer		
			Columns			Columns			Columns		
			1	2	3	1	2	3	1	2	3
1..................	20 hours	18.2	80	..	..	..	..	..	44	..	..
2..................	25 hours	19.5	86	..	..	..	..	..	70	..	..
3..................	48 hours	10.0	86	72	69	53	0	0	52	0	0
4..................	48 hours	13.5	78	47	47	65	0	0	64	0	0
EXPERIMENTS WITH DISTILLED WATER.											
5..................	48 hours	11.8	88	71	70	18	17	17	13	9	8
6..................	48 hours	10.0	78	73	73	22	23	23	16	16	16

NOTE.—The air currents were filtered through glass wool in the case of experiments 3, 4 and 5; they were unfiltered in 1, 2 and 6.

On referring to the experiments with sea water, it will be seen that when, as in the case of the first columns of each of the experiments, Nos. 3 and 4, the air current was dry, and evaporation from their exposed surfaces could freely occur, the rate of "streaming" of dissolved air from the surface layer to the bottom was remarkably uniform and comparatively rapid. Thus the air content of the bottom layers of the first columns in Nos. 3 and 4 was nearly equal to that of the middle portions of the same columns, respectively; it was 53 and 52 per cent. of saturation in No. 3, and 65 and 64 per cent. in No. 4, respectively.

In the case, however, of the second and third columns in each experiment, no sign of re-aeration is indicated by the results recorded. The only apparent explanation of this is that the current of air, employed to keep the surface layers of the columns in question continuously broken, could not cause any evaporation therefrom because they had been saturated during their passage through the respective first columns. It may be noted that the results obtained with these columns conclusively prove that re-aeration by diffusion according to Fick's law cannot take place to a sufficient extent to be of any practical importance in polluted tidal waters.

Incidentally it may be pointed out that very different results would be obtained if the quantity of oxygen, which should be found, according to the proposition of Black and Phelps, at the bottom of each of the columns of sea water in experiments 3 and 4, were calculated out by means of their suggested formula. The quantity would be the same for each column, viz., about 6 per cent. of saturation, if the surface layer of each column had been preserved unbroken during the experiment, and presumably more under the condition of the broken surfaces of these experiments—very different, it will be observed, from the quantities actually found by experiment, which were 52 and 64 per cent. of saturation in the case of each initial column, from the exposed surface of which evaporation could freely occur; and 0.0 in the case of the other columns, from the exposed surfaces of which evaporation could not occur. *Thus, whether evaporation can or cannot occur, Black and Phelps' proposed formula yields seriously misleading results.*

As these experiments directly prove, the rate of diffusion of dissolved oxygen in water is so slow that it cannot possibly affect the problem of the rate of re-aeration, so far as the question of supply of oxygen available to large volumes of tidal water for the purpose of digesting and satisfactorily disposing of sewage matters, which may be discharged into them, is concerned.

The results obtained from the experiments with the columns of distilled water were, it will be seen from the above table, quite different in character and magnitude from those obtained with the sea water columns. They show that "streaming" took place in each of the three tubes, but more markedly with unfiltered than with filtered air.

A tendency for the dissolved air to remain concentrated in the upper portions of each column is also indicated.

The results of these experiments illustrate the second form of "streaming" above referred to. It is evidently not due, at least that which is shown by the second and third columns in each experiment, to evaporation at the exposed surface, but to some other cause—possibly to the formation, as suggested by Huefner in his paper on the diffusion co-efficient of gases in water, of layers of increased density, due to the dissolved air, at the exposed surface, or possibly to some other cause as yet unrecognized.

It is important for practical purposes to note that this latter form of "streaming" takes place much more slowly than does the form due to evaporation. It is, however, much more rapid than true diffusion according to Fick's law, and must consequently be regarded as a more important factor in the question of the rate of re-aeration of polluted tidal waters.

The writer has, it may be added, confirmed the general character of the results of the above experiments by several others.

The precise effect which evaporation from the surface of a polluted tidal water exercises on the rate of re-aeration of the mass of water below the surface is not difficult to understand.

As evaporation proceeds, the surface layer, consisting as it does of a solution of sodium chloride and of other salts, becomes concentrated, and "streams" vertically downwards, carrying with it the atmospheric gases, which it dissolved when exposed to the air.

The writer has further found from experiments, specially devised for the purpose, that the "streams" of the concentrated and air-saturated layers, from the exposed surfaces of columns of de-aerated sea water, passed vertically downwards to the bottom without suffering any marked loss of dissolved air by lateral diffusion.

This explains the fact, shown by the above experiments with sea water, that the re-aeration of the de-aerated columns of sea water proceeded practically at the same rate throughout their whole length—the lower half of the columns being re-aerated almost as quickly as the upper halves. It follows from this that the rate of re-aeration of a polluted tidal water, if approximately uniform in density, will approximately vary inversely as its depth.

In this way sea water exhibits another important advantage over distilled water, so far as the question of re-aeration is concerned.

Bearing in mind the foregoing prefatory remarks, the question of the rate at which the re-aeration of a given polluted tidal water may be expected to proceed under, say, average weather conditions, at different seasons of the year, may be usefully considered.

The known important factors, which may be regarded as normally affecting the question, have been shown above to be: area surface exposed to the air (depending upon the state of the wind and the flow of the water), the temperature of the water, the humidity of the air, and the uniformity, or otherwise, in density of the water in a vertical direction downwards.

It is quite evident that under their combined influence the rate may vary practically from zero to a value of such magnitude as to be of great practical importance especially during summer season.

It need scarcely be pointed out, however, that a good deal of work has yet to be carried out, both in the laboratory and on the open water, before a definite value can be put to the extreme rate at which re-aeration under the most favorable conditions would occur, or even to the average rate—both would certainly vary with different classes of inshore waters.

But it is fair to conclude from the laboratory experiments that have been made that the rate of re-aeration, under normal conditions, of a given class of tidal waters would always be of practical importance in the consideration of the question of the maximum power that a particular water of the class might possess for the disposal and digestion of sewage matters within limits of safety to public health and fish life.

The experiments recorded in the above table show, for instance, that when the surface layers of de-aerated sea water columns, 6 feet deep, were kept continuously broken by a current of air, the re-aeration proceeded uniformly down the whole depth of the column at a rate amounting to 50 per cent. of saturation in the case of one experiment, and to 64 per cent. in the case of the other, in 48 hours; or at the rate of 0.067 cc., and 0.077 cc., oxygen per litre of water, respectively, per hour. And in the opinion of the writer it may be concluded from these experiments, and from others that he has made, that the rate will approximately vary inversely as the depth.

These columns were, it must be noted, uniform in composition, but not quite so in density, since the upper portion of each was kept at 3 to 4° C. higher than the lower portions; that is to say, the lower portions of each column were slightly denser than the surface layer. On the whole it may be taken that the results obtained from the experiments with these columns probably indicate about *maximum rates* of re-aeration which may occur in inshore waters.

As regards the humidity of the air, or the actual extent of evaporation which took place during these experiments, neither was noted

Another experiment with de-aerated sea water, which was carefully designed and carried out to exclude all danger of movement in the water except that due to "streaming," showed a rate of re-aeration, practically uniform to depth of 12 feet, amounting to 51 per cent. of saturation in 48 hours; when the air current in this experiment was dried by passing it through concentrated sulphuric acid. The temperature of the surface layer of the column at the conclusion of the experiment was 6.9° C.

The rate of re-aeration of a polluted tidal water by "streaming," resulting from evaporation, would no doubt be retarded if the surface layer were much fresher than the deeper layers, but it would not be stopped altogether, as assumed by Black and Phelps, at least in the case of the waters of New York harbor, where the difference between the surface and bottom layers, in their fresh water content, rarely exceeds 12 per cent. and generally does not amount to more than 6 per cent. (see Section III).

The writer has found as a matter of fact that "streaming" takes place freely in columns of sea water in which the upper portions have been fresher than the lower portions, when in fact the upper portion has had as much as 20 per cent. fresh water mixed with it.

In connection with this point, the writer would like to point out that the aeration of the deeper portions of a tidal water ought not, for reasons which will be explained in Section III, to be allowed appreciably to be affected by sewage matters. If they are, it usually is caused by a fouled bed, and this should not be allowed to occur under any circumstances.

III. The Permissible Limit of Exhaustion of the Dissolved Oxygen in the Waters of New York Harbor.

The question of the permissible limits of exhaustion, by sewage matters, of the dissolved oxygen in the waters, generally, of New York harbor, or locally, in any particular portion of them, largely depends upon the extent to which the configuration of the harbor, and volume and rate of flow of its tidal currents, including land water, naturally favor the satisfactory disposal of the sewage matters, which are being discharged into it, whether by transport with its ebbing currents to the open waters beyond it, or by direct, or indirect, oxidation by means of the oxygen dissolved in its waters.

The data necessary for the discussion of this latter question have been carefully investigated and collected together by the Metropolitan Sewerage Commission, and have been published by that body in its Report of April 30, 1910, and it will be first considered.

New York harbor, for the purpose of the discussion of the latter question, may be regarded as consisting of a central basin, viz., the Upper Bay, with the East river, the Hudson river, Kill van Kull and the Narrows acting as inlet and outlet channels for land and tidal waters.

The areas, average depths and volumes of the waters lying below the level of mean low water in the different divisions of the harbor, and the average tide ranges, are given in the Commission's Report, p. 156, as follows:

TABLE III

Lengths, Depths, Areas and Volumes of Water, and Tidal Ranges.

Division of Harbor	Length in Miles	Area Square Miles	Average Depth Feet	Volume* below M. L. W.	Average Tide Range** Feet
Upper bay	6.5	20.74	22.4	12970	4.4
Hudson river, Battery to Mt. St. Vincent	16.0	14.49	30.7	12330	4.2
East river, Battery to East 88th street	20.0	3.31	29.2	2700	4.7
East river, East 88th street to Old Ferry Point	6.5	8.98	22.3	5590	6.2
East river, Old Ferry Point to Throgs Neck	2.25	2.51	41.0	2870	7.1
Harlem river	8.0	0.49†	13.6†	187.7†	5.3
Newark bay	5.0	8.35	6.6	1542	4.6
Kill van Kull	4.5	1.12	23.4	728	4.8
Arthur Kill	15.0	4.93	12.6	1735	5.4
Total water surface		64.92			
Total volume of water below mean low water				40652.7	

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*In millions of cubic feet. **No great difference occurs in the range of Spring and Neap Tides.

†Editorial Note by Commission. These figures, taken from an early report of the Commission, are in error, but they do not materially affect Dr. Adeney's opinions.

The volumes of flow, in millions of cubic feet, in the different divisions of the harbor, per lunar hour, are given in the same Report, p. 178, as follows:

TABLE IV

VOLUMES OF FLOW IN MILLIONS OF CUBIC FEET PER LUNAR HOUR IN NEW YORK HARBOR

Lunar Hour	Hudson River		East River		Kill van Kull		The Narrows		Water in Upper Bay	
	Into Upper Bay	Out of Upper Bay	Into Upper Bay	Out of Upper Bay	Into Upper Bay	Out of Upper Bay	Into Upper Bay	Out of Upper Bay	De-creasing	In-creasing
I............	1,600	—	1,010	—	340	—	—	3,160	290	—
II............	1,730	—	730	—	160	—	—	2,490	—	70
III............	1,430	—	260	—	—	65	—	1,120	—	400
IV............	710	—	—	270	—	250	430	—	—	600
V............	—	155	—	730	—	380	1,820	—	—	650
VI............	—	860	—	1,010	—	400	2,690	—	—	540
VII............	—	1,360	—	990	—	320	2,840	—	—	290
VIII............	—	1,460	—	710	—	150	2,230	—	70	—
IX............	—	1,200	—	260	70	—	1,020	—	400	—
X............	—	600	290	—	260	—	—	480	600	—
XI............	200	—	750	—	390	—	—	2,060	650	—
XII............	1,050	—	1,030	—	420	—	—	3,000	540	—
Ebb flow......	6,720	—	4,070	—	1,640	—	—	12,310	—	—
Flood flow....	—	5,635	—	3,970	—	1,555	11,030	—	2,550	2,550

The above figures show that the average total flow through the Narrows, out of and into the Upper bay, amounts to 12,310,000,000 and 11,030,000,000 cubic feet, respectively. "The resultant flow, or excess of ebb over flow, is the land water from the drainage areas above the Narrows, and the excess of flow through the East river from the Sound. The land water is 1,182,300,000 cubic feet, and the resultant through the East river may be taken as 100,000,000 cubic feet, per tidal cycle, or a total of 1,282,300,000 cubic feet" (p. 172).

It is to be noted that the so-called East river is in reality a strait connecting Upper New York bay and Long Island Sound. "Tidal waves enter at both ends, the Sound wave being approximately twice as high as the Bay wave. There is a decided interference of these waves traceable to the southerly end of Blackwell's Island."

"The two tides ordinarily meet at a point between Throgs Neck and Stepping Stones Light, so that, strictly speaking, the flood (or ebb) currents on each side of this meeting point flow in opposite directions. The ebb current may therefore be considered as flowing the entire length of the East River from Throgs Neck to the Battery, and the flood current as flowing from the Battery to Throgs Neck" (p. 174).

On comparing together the figures in the above two tables, it will be seen that of the average total volume of salt and fresh waters, which the harbor contains and receives within a cycle of a flood and ebb tide, only about 23.00 per cent. passes out of the harbor through the Narrows during the ebb flow. It follows from this that the water remaining in the harbor at a low tide is freshened, but never completely displaced and renewed, by clean sea and land waters flowing into, and out of, the harbor during the ensuing tidal cycle, as occurs in the case of certain other harbors more fortunately circumstanced in this particular; *e. g.,* Dublin harbor on the River Liffey, Newport (Monmouthshire) harbor on the Usk, Liverpool on the River Mersey (see Appendix 6 to the Fifth Report of the Royal Commission on Sewage Disposal).

The detailed investigation which the Metropolitan Sewerage Commission has made of the tidal phenomena of the harbor shows that this conclusion is fully warranted in point of fact, as will be gathered from the following quotation from p. 75 of the Report of the Commission:

"*Imperfect Conditions for Assimilation.* The quantity of water which flows in and out of New York harbor, although large, is not a measure of the capacity of the harbor to transport or assimilate sewage. The idea of transportation involves the assumption that the matters which are carried away are not brought back again. The oscillation of the tide carries the sewage back and forth indefinitely. The idea of assimilation involves the assumption that the sewage becomes so mingled with the water as properly to be considered part of it. Again, investigation shows that this condition is not fully fulfilled.

"The movement of the tides produces a refreshing effect upon the harbor, but this benefit is restricted because (a) tidal action is usually least in those places which need it most; (b) thorough mixture of the sewage with the water does not always occur promptly; (c) the currents are intermittent, and not continuous as are those of a river flowing in one direction; (d) the action of the tidal currents carries some sewage matters on the surface and some toward shore; (e) the force and direction of the tidal currents are materially influenced by the wind; (f) excepting near the sea and Sound entrances the same water flows back and forth and is not pure sea water by any means.

"*Oscillatory Movement of Harbor Waters.* Contrary to popular belief, the movement of river and tidal water to sea does not proceed in a regular and reliable manner. Studies of the course followed by objects so constructed as to float just below the surface of the harbor have shown that the vater oscillates back and forth, sometimes to an indefinite extent, before escaping to the sea.

"In the more open parts of the Hudson river and Upper and Lower New York bays there is a generally northward and southward oscillation, the southward movement being in excess.

"The waters which pass out of the harbor by way of the Narrows go to sea, for the most part, by the northerly channels of the Lower Bay.

"The water of Newark bay oscillates between the head of the bay and the eastern end of the Kill van Kull, eventually escaping chiefly to New York bay and so to the ocean.

"The water flows more rapidly in the East river than in any other arm of the harbor, but most of the water moves back and forth, like the pendulum of a clock, without escaping to the ocean or to Long Island Sound. A buoy which was made to float, except for a small tell-tale, just below the surface of the water, was followed back and forth for three and a half days in the East river. At the end of this time it had travelled 108 miles without passing out of this stream. It returned several times to the locality where it had been set adrift."

Although, as is obvious from the foregoing considerations, the waters of New York harbor are only freshened to a slight extent by the relatively small quantities of land and sea waters which they receive during each tidal cycle, they must be credited with the advantage, which the physical conditions of the harbor ensure them, of becoming, on an average, somewhat rapidly intermixed with the same freshening waters, and also, it may be added, with the sewage matters draining into them.

This tendency to intermixture is shown by the fact that the lighter land waters are not found to be restricted to the surface and upper layers of the heavier salt waters in the harbor, but generally mingled with them, so that, although the larger proportions of land water occur at the surface, considerable proportions are also to be found at the bottom; the differences between the surface and bottom layers, in their fresh water content, rarely exceed 12 per cent., and generally do not amount to more than 6 per cent. (Commission's Report, pp. 525 to 530.)

Again, the very careful and extended examinations which the Metropolitan Commission has made of the quantities of oxygen that occur dissolved in the surface and bottom waters of the several divisions of the harbor, at different states of the tide, also bear witness of the considerable amount of mingling which occurs within the harbor between the sea and land waters, especially in vertical directions from the surface to the bottom. The results of the examinations referred to show that "as a rule there was not much difference between the amount of oxygen in the water at the surface and in that at the bottom." (P. 409.)

The explanation of this comparatively intimate intermixture of the land (including liquid sewage matters) and sea waters, which occurs within the harbor, is no doubt to be found in the peculiar configuration of the harbor, and in the to-and-fro oscillating movements produced in its waters by the play of its tidal currents, as above described. These latter vary considerably, and are fairly strong at times. The average maximum and minimum velocity in each direction of the currents at the principal points in New York harbor, and at a time when each current is strongest, are given in the subjoined table. It is quoted from p. 182 of the Commission's Report.

TABLE V

Velocities of Currents in the Channels of New York Harbor

	When Conditions are					
	Mean		Maximum		Minimum	
	Ebb	Flood	Ebb	Flood	Ebb	Flood
The Narrows	2.0	1.6	2.8	2.3	1.1	0.9
Hudson river, 39th street	3.0	2.0	4.7	3.0	1.4	1.2
East river, Brooklyn Bridge	3.8	3.6	4.6	4.4	2.6	2.5
East river, 11th street	3.0	2.9	3.7	3.5	2.1	2.0
East river, 19th street	2.6	2.3	3.2	2.8	1.8	1.6
East river, 31st street	2.9	2.6	3.5	3.2	2.0	1.8
Kill van Kull, Port Richmond	2.2	1.8	2.7	2.2	1.5	1.2
Kill van Kull, Bergen Point	2.0	1.8	2.4	2.2	1.4	1.2
Harlem river, 144th street	1.0	1.0	1.2	1.2	0.7	0.7
Harlem river, High Bridge	1.9	1.8	2.3	2.2	1.3	1.2

The above velocities are surface velocities or the velocity of the water just below the surface and are expressed in knots per hour.

With the foregoing information in mind regarding the physical features of the harbor and of its waters, a definite answer may be given to the question set down in the opening paragraph of this section, viz., the extent to which the configuration of the harbor, and the volumes and rate of flow of its tidal currents, including its land water, favor the satisfactory disposal of the sewage matters which are discharged into it.

The powers possessed by the harbor waters for transporting the sewage solid matters to open waters beyond the harbor boundaries are obviously extremely limited.

They are nil so far as the heavier solid matters are concerned, and at best they can transport a small fraction only of the lighter sewage solids beyond the harbor limits during the ebbing tides.

The Commission has dealt very fully in its Report (pp. 432-446) with the subject of the powers of the currents, which obtain in the different divisions of the harbor, for carrying solid sewage matters, and it is unnecessary therefore here to consider them except to emphasize the point brought out in the Report that the currents in the harbor stop and reverse four times a day, and that they are to be regarded as available more for moving, for short periods of time, particles which have settled upon the bed of the harbor, than as currents capable of transporting solid matters beyond the harbor, and of so preventing deposits therein (p. 441).

The Commission has also made a careful and valuable investigation of the bed of the harbor to determine the distribution of the solid sewage matters upon it; and it has found that "a large part of the bottom of the harbor was polluted with deposits of solid matters from sewage. The bottom of the Upper bay was generally polluted, although the Jersey flats west of a line from Constable Hook to Black Tom Island were found to be singularly free from sewage deposits. The bottom near Manhattan Island, near the Jersey shore opposite Manhattan, and the bottom near the Long Island shore in the East river, were polluted almost everywhere, at least to the pierhead line."

"Midstream in the Hudson and East rivers the bottom was fairly free from deposits of sewage solids, and was generally so hard that the samples could be obtained only with difficulty. The Lower bay was polluted, particularly in the principal ship channels. Frequent foul deposits were found in the Kill van Kull and in the Newark bay, especially near Elizabethport, Port Richmond, Hoboken and at the mouth of Gowanus canal." (P. 425.)

The harbor waters present more favorable conditions for the effective disposal of the *liquid* sewage matters draining into them, *provided the outfall sewers are suitably situated.*

As already shown, an ebb tide may transport about 23 per cent. of the total volume of liquid sewage matters, draining into the harbor during a tidal cycle, to open water beyond the harbor; while the waters available for diluting the residual 77 per cent. that remain within the harbor are sufficient in volume to ensure the gradual purification of the same by bacterial oxidation, the products of oxidation being gradually carried, beyond the limits of the harbor, away by subsequent ebb tides.

The liquid sewage matters, moreover, unlike the sewage solid matters, do not continue to accumulate indefinitely within the harbor, but cease to do so when the total quantity of them remaining within the harbor has reached a certain maximum limit, which can be approximately estimated for the average conditions, which obtain in the harbor, by a simple calculation.

The total volume of sewage, which is produced in the various towns and districts draining into the harbor, has been estimated by the Commission to amount to 741,000,000 gallons, or 118,980,000 cubic feet (p. 146).

It may be assumed, for the purpose of calculation, that the volume of sewage daily produced is constant, and the whole of it drains into the harbor.

It may further be assumed that—

(1) the flow is uniform during the day;

(2) the sewage matters, which drain into the harbor, during each tidal cycle, become intimately mixed with the waters, which the harbor contains and receives during the same cycle;

(3) the sewage matters undergo no appreciable chemical change or purification during the period of accumulation;

(4) the waters of the harbor, to commence with, are free from sewage pollution;

(5) the land and the flood waters entering the harbor through the Narrows from the Lower bay, and from the Sound, are practically free from sewage pollution.

The last assumption is warranted from the observations and the results of the investigations which the Commission has made touching this question. These are:

(1) that the ebbing waters which pass out of the Narrows "go to sea, for the most part, by the northerly channel of the Lower bay" (p. 75);

(2) that the flowing waters, which enter the Narrows with the flood tide, contain a much smaller proportion of land water (on an average about 10 per cent.) than does the water in the Upper bay (on an average 25 per cent.);

(3) that the land waters and flood waters coming in from the Lower bay and Sound are practically saturated with dissolved oxygen (pp. 412 and 413).

If the whole of the sewage which is daily produced drains into the harbor, it may be taken for practical purposes that 59,400,000 cubic feet will flow into it during a cycle of flood and ebb tide, *i. e.*, during 12 lunar hours. A fraction of it will pass out, during the first tidal cycle, through the Narrows with the ebb tide, approximately similar to the fraction of the harbor waters which, as above shown, flow out of the harbor during an ebb tide under average conditions, namely, about 23 per cent., leaving about 77 per cent. intermixed with the harbor waters at mean low tide.

The quantity of liquid sewage matters subsequently remaining within the harbor will obviously gradually increase with each succeeding tidal cycle until the quantity which passes away with the ebb tide—assuming for the moment that the accumulated liquid sewage matters have become intimately intermixed with the harbor waters, and have meanwhile undergone no change—becomes equal to that which drains into the harbor during the tidal cycle.

This would occur when the total volume of liquid sewage matters, remaining intermixed with the harbor waters at mean low tide, had become equal to about 196,500,000 cubic feet, which it would do after about 20 tidal cycles.

The volume of liquid sewage matters passing out of the harbor through the Narrows would then, on an average, continue to equal the total volume of liquid sewage matters flowing into the harbor during a complete tidal cycle, that is 59,490,000 cubic feet.

The average total volume of water passing out of the harbor through the Narrows during the ebb tide is, as already stated, 12,310,000,000 cubic feet. If the above quantity of sewage matters formed part of this 12,310,000,000 cubic feet, and if it were intimately mixed with the ebbing water, the average dilution of sewage matters would be in the proportion of 1:200. Similarly the dilution of the liquid sewage matters remaining in the harbor at mean low tide would be in like proportion.

It need scarcely be pointed out that the above calculated value for the maximum extent to which liquid sewage matters can accumulate within the harbor waters is, under the average conditions which obtain in it, an extreme value, and one which can never be reached in practice. Because it has been assumed for the purpose of calculation that, during the time required (about ten days) for the liquid sewage matters to accumulate in the harbor to the maximum extent, they undergo no chemical change or purification. In practice, however, they at once, upon discharge into the harbor, come under the influence of an active process of indirect oxidation, set up by the bacterial flora, which has, it may certainly be taken for granted, been thoroughly well established in the waters of the harbor, under the favorable conditions for growth presented by the polluted condition of those waters, and which there can be no doubt, indirectly oxidize the liquid sewage matters decidedly more quickly than would be anticipated from laboratory experiments upon the indirect oxidation of sewage matters by water bacteria, under like conditions of dilution and temperature.

As a matter of fact, therefore, the liquid sewage matters which are to be found at any time polluting the harbor waters are not all in the crude state, but in various stages of oxidation, from the earliest steps of the carbon fermentation of the organic constituents of fresh sewage to, no doubt, the later steps of the nitrogen fermentation of the ammonium compounds and humus organic matters remaining over from the fermentation of the organic constituents of the sewage that had drained into the harbor at an earlier date.

It will be convenient at this point to digress for a time from the subject of the Report in order to explain the above technical terms.

According to modern and now generally accepted views, the most important effect upon tidal waters of the introduction of sewage into them, and one which invariably follows it, is the more or less complete exhaustion of their dissolved oxygen.

The loss of oxygen may be caused by three distinctly different actions of the sewage, thus:

(1) the waters carrying the sewage matters, from their own state of deaeration, may lower the aeration of clean waters simply by dilution;

(2) the sewage matters may contain substances which are easily oxidized when brought into direct contact with the dissolved oxygen of clean waters; such substances do not, however, usually occur in fresh sewage matters, but only in sewage that has been subjected to putrefactive processes, especially so in the presence of sea water, as for instance when sewage solids are allowed to accumulate on the bed of a tidal water, and to undergo bacterial fermentation in the absence of a sufficient supply of oxygen;

(3) the organic constituents and the ammonium compounds of the sewage, when in the fresh state, exert no direct action upon the dissolved oxygen of clean waters; they are gradually oxidized, it is true, when mixed with clean water, but only during the fermentative processes set up by water bacteria in the presence of an excess of dissolved oxygen, when they indirectly cause a loss of the said dissolved oxygen.

When town sewage, in the fresh condition, is allowed to drain into relatively large volumes of clean water, the last only of the above three de-aerating actions will show itself by appreciable influence upon the dissolved oxygen of the same. When, however, the conditions are such that all three actions may be set up, they will take effect in the order in which they are enumerated above.

The effect of the first is obvious, and it is practically instantaneous. The effect of the second may also be practically instantaneous. Thus sulphuretted hydrogen and black sulphide of iron, both of which are amongst the most commonly occurring bodies of a directly oxidizable character to be found in sewage matters when subjected to putrefactive processes, especially in the presence of sea water, are oxidized by direct contact with the dissolved oxygen in clean water with great rapidity.

The effect of the third action upon the dissolved oxygen of clean waters is very distinctly different, especially in those cases when the clean waters are only polluted with relatively small quantities of sewage matters. In these circumstances the exhaustion of the dissolved oxygen proceeds with extreme slowness, and occupies several days under natural conditions.

It must be remembered in this connection that oxygen is only very slightly soluble in water, and that consequently tidal waters, even when saturated with it, hold relatively very small quantities of the gas in solution. Hence, if the admixture of sewage matters with clean tidal water be strictly controlled in accordance with the power of the latter to supply sufficient dissolved oxygen for the complete fermentation of the former, the proportions in which the sewage matters may be mixed with the tidal waters must also be very small; and under these conditions the growth and development of water bacteria also proceeds slowly, and the rate with which they ferment the sewage matters and effect their oxidation is likewise very slow, so slow, in fact, that several days are required for the completion of the fermentative processes which they give rise to.

A further important point to be noted in reference to the fermentation of sewage matters by water bacteria is that it is effected in two distinct and progressive stages. The organic matters are first completely fermented, and are almost entirely oxidized during the process to the ultimate mineralized products, water, carbon dioxide and ammonia. But small quantities of organic substances also appear amongst the final products of this process of fermentation. They are excretory bodies, and possess the chemical and physical properties of the humus of cultivated soils, and of the organic matters in peaty colored river and lake waters.

When the fermentation of the organic constituents by water bacteria has been completed, the second stage of the fermentative processes may occur, and during this process the ammonium compounds, together with the humus matters formed during the first process, are oxidized to nitrites, nitrates, carbon dioxide and water.

The terms "carbon-fermentation" and "nitrogen-fermentation" are now employed to describe these two stages of fermentative processes; and with their employment the following classification of the bodies which may occur in polluted waters has been adopted:

(1) carbon fermentable substances, that is nearly all existing organic substances other than antiseptics, which have not been subjected to the fermentative action of water bacteria;

(2) nitrogen fermentable organic substances, or nitrifiable organic substances, that is, organic substances which have resulted from the carbon fermentation of other organic bodies;

(2a) ammonium compounds.

It will be observed that the fundamental conception of this classification is that the oxidation of organic carbon to carbon dioxide constitutes the central feature of the first stage of fermentative change; and that the oxidation of ammoniacal nitrogen to nitrous and nitric acid constitutes the central feature of the second stage of fermentative change, and that these products of the second stage of change are the analogues of the product, carbon dioxide, of the first stage. It will also be observed that the sequence of these changes is in strict conformity with thermo-chemical principles.*

To return to the subject of this Report, the New York sewage must be a weak one, having regard to the large consumption of water per head of the population, and the quantity of oxygen which would be required completely to ferment 1,000 volumes of it, after the removal of the heavier suspended solids as far as possible by mechanical subsidence, would on an average certainly not exceed 250 cc., measured at O C., and 760 mm., bar. So that if the New York harbor waters be regarded as being uniformly polluted with 0.5 per cent. of liquid sewage matters, they would require 1.25 cc. dissolved oxygen per liter for their complete fermentation. Of this quantity about 0.75 cc. would probably be required for the fermentation of the organic substances, and about 0.5 for that of the ammonium compounds, in the sewage matters.

Data are not yet available to show at what rate the dissolved oxygen of the harbor is actually absorbed by the liquid sewage matters polluting them—it would be different at different seasons of the year, being the more rapid the warmer the season.

The writer, however, from a considerable experience, believes that the maximum rate would not exceed 0.75 on an average throughout the waters of the harbor, in 48 hours, at summer temperatures of 25 C., when it would be at a maximum. It will be seen from Section 2 of this Report that this rate of absorption of dissolved oxygen would be completely counterbalanced by the rate of re-aeration, by absorption of oxygen from the atmosphere, of the harbor waters, under ordinary atmospheric conditions and at a temperature of 25 C.

On reviewing the foregoing discussion regarding the extent to which the physical features of New York harbor, and of its waters, can assist the disposal of the sewage matters discharged into them, it may be concluded:

(1) the heavier sewage solids cannot be transported beyond the harbor, but must remain and accumulate within it, and form permanent foul deposits over a large portion of the bed of the harbor;

(2) the harbor waters are capable of satisfactorily dealing with the large volumes of *liquid* sewage matters at the present time draining into them, and without, on an average, suffering appreciable diminution of their dissolved oxygen, and only markedly so in the vicinity of the outfall sewers, provided

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*An exposition of the scientific basis upon which the modern views of the chemistry of polluted waters is founded will be found in Section 1, by the writer, of the Appendix VI.

> that the points of discharge be carefully selected, so that the sewage matters will not drain into slack waters, but will pass away into tidal currents, and where they can be subjected to favorable conditions as far as they are available, for intermixture with the harbor waters.

The last conclusion may, at first sight, seem to be at variance with the results obtained by the Commission from its investigations of the dissolved oxygen content of the waters in different parts of the harbor and at different states of the tide.

But a little reflection will show that this is not necessarily so. The deficiency in dissolved oxygen from which, as the Commission has shown, the waters of the harbor generally suffer at the present time, is chiefly, in the opinion of the writer, to be ascribed to the sewage solids, which have been for some years past, and are, accumulating over the greater part of the harbor, and are there forming foul deposits and permanent sources of injury to the waters flowing over them.

The writer has had occasion to study the effects of the deposition of solid sewage matters in a number of tidal rivers and estuaries in Great Britain, and has been led to the conclusion that, of all the constituents of sewage the solid matters in suspension cause the most injurious results in tidal waters, unless the tidal currents are sufficiently strong to transport them from the point of discharge, and effectually to dispose of them by breaking them up and dispersing them through sufficiently large volumes of water to ensure that their subsequent purification by bacterial fermentation shall be effected in the presence of an ample supply of dissolved oxygen.

When the suspended solids are not so transported and dispersed, but are deposited, as in the case of New York harbor, in close proximity to the outfall sewers, they undergo putrefactive fermentation, during which sulphuretted hydrogen, ferrous sulphide and other products of chemical reduction are formed, and impart to the deposits a black color and foul odor. Gaseous bodies, such as marsh gas, carbon dioxide and hydrogen are also formed, and collect in small bubbles about the putrefying deposits. From time to time masses of black mud are detached by bubbles of these gases, and are buoyed up by them towards the surface of the overlying waters. In this way, and by the mechanical action of the waters themselves, under the influence of high winds or of strong tidal currents, black mud from a fouled bed becomes dispersed through the overlying waters, and injuriously affects them.

The effects which sewage solid matters exert when they become diffused through tidal waters, after having been subjected to putrefactive processes in the presence of sea water, are much more injurious than those which the same matters cause when *in the fresh condition,* whether liquid or solid, with tidal waters.

The explanation of this is simple. During putrefactive processes in the presence of the sulphates of sea water, relatively large quantities of sulphides are formed. These sulphides are very easily oxidized, while in the wet condition, by the direct chemical action of dissolved oxygen upon them. Consequently, when masses of black, putrid mud become detached from a foul bed, and become diffused through the overlying tidal waters in the manner above described, the sulphides are rapidly oxidized, and the waters at once show, on examination, more or less considerable deficiency in dissolved oxygen according to the quantity of sulphides mixed with them.

It is obvious that when the bed of a harbor, such as New York, becomes grossly polluted by sewage deposits, it is impossible to control the amount of sulphides and other directly oxidizable products of putrefaction that may at any time become dispersed through the tidal waters, or in any way to limit their injurious effects upon the waters.

Liquid sewage matters, on the other hand, in the fresh condition in which they are usually discharged from a tidal outfall, are *not* oxidized by direct chemical action with dissolved oxygen. On the contrary, their oxidation can only be indirectly effected by fermentation processes set up by water bacteria in the presence of an excess of dissolved oxygen.

When liquid sewage matters are discharged, under proper controlling conditions, into tidal waters, they rapidly become diluted, and under the condition of considerable dilution (in the proportion, say, of 1:50 or 100 and upwards), the oxidation of the sewage matters by bacterial processes proceeds very slowly and progressively in stages, and not rapidly and practically in one step, as occurs in the case of the direct oxidation of sulphides and other reduced products of putrefaction.

Two series of experiments which the writer made for the Royal Commission on Sewage Disposal of England (see Appendix VI, pp. 88, 433-434), may be quoted to illustrate the difference in behavior of processes of direct and indirect oxidations, so far as the course and rate of absorption of dissolved oxygen are concerned. They were made with (1) a sample of grossly polluted tidal water, after it had been kept out of contact with air and allowed to putrefy until it had become very offensive and decided quantities of black sulphide of iron had been formed; and with (2) a sample of liquid sewage matters in a fresh and non-putrefactive condition from Belfast.

Experiment with Sample 1. A portion of the sample of known volume was kept gently shaken by means of a mechanical rocker in a closed vessel with an excess of air, and the volume of oxygen which was absorbed was ascertained periodically by a method described by the writer on pp. 103-105 of the Appendix above referred to. The results which were obtained are recorded in the following table:

TABLE VI

Determinations of the Rates of Absorption of Oxygen by a Sample of Polluted Tidal Water Showing That Directly Oxidizable Products of Putrefactive Fermentation May Absorb Oxygen Much More Quickly than Indirectly Oxidizable Substances.

Time	Oxygen Absorbed Expressed in cc. per Litre, at 0° C., and 760 mm. Bar.	Time	Oxygen Absorbed Expressed in cc. per Litre, at 0° C., and 760 mm. Bar.
First day (24 hours) after commencement	57.5	Sixth day	6.0
Second day	8.5	Seventh day	6.2
Third day	4.8	Eighth day	6.2
Fourth day	5.8	Ninth day	3.7
Fifth day	5.0	Tenth day	0.0

The sample at the commencement of the experiment contained, as above noted, black ferrous sulphide in suspension. At the end of 24 hours the black color had entirely disappeared, so that it may be taken that the reduced products of putrefaction had mostly, if not entirely, been oxidized by this time, when 57.5 cc. oxygen per litre had been absorbed. During the next eight days the indirectly oxidizable substances were gradually fermented, as shown in the above table. The total volume of oxygen which they had absorbed in that time was 46.2 cc. per litre. Thus the easily oxidizable substances absorbed more oxygen in one day than did the indirectly oxidizable substances in eight days.

Experiments with Sample 2. The sewage employed in the second series of experiments was an average sample collected from the main sewer of Belfast. It was mixed with a little magnesium hydrate to fix the free carbon dioxide, and allowed to stand for a short time. The liquid matters were then decanted from the heavier solids. Portions of the decanted liquid, immediately after being well stirred, were mixed with distilled water and with sea water in proportions of 20 per cent. Portions of these mixtures, and of the sewage, were separately placed in suitable vessels, and kept gently and continuously shaken, in contact with an excess of air, by means of a mechanical rocker. The volume of oxygen, which was absorbed by each portion, was daily ascertained by the same method as that employed in the above experiment with Sample 1. The following results were obtained:

TABLE VII

DETERMINATIONS OF THE RATES OF ABSORPTION OF OXYGEN BY A SAMPLE OF LIQUID SEWAGE MATTERS, IN THE FRESH CONDITION, AND OF DILUTIONS OF THE SAME WITH FRESH AND SEA WATERS.

NOTE. The free carbon dioxide in the sewage and in the dilution was fixed by the addition of magnesium hydrate The volumes of oxygen are expressed in cc. at O. C., and 760 mm. bar.

	Sewage		Mixtures of 20 Per Cent. Sewage with			
			Sea Water		Fresh Water	
	Total oxygen absorbed	Oxygen absorbed per 24 hours	Total oxygen absorbed	Oxygen absorbed per 24 hours	Total oxygen absorbed	Oxygen absorbed per 24 hours
At end of—						
1st day	51.5	51.5	5.8	5.8	5.8	5.8
2nd “	86.5	35.0	14.9	9.1	15.9	10.1
3rd “	106.6	20.1	19.8	4.9	20.4	4.5
4th “	115.4	8.6	22.7	3.9	24.9	4.5
5th “	119.7	4.3	24.3	1.6	25.9	1.0
6th “	123.2	3.5	25.9	1.6	26.5	0.6
7th “	126.4	3.2	27.4	1.5	27.4	0.9
8th “	129.7	3.3	28.5	1.1	28.5	1.1
10th “	136.1	3.2	30.2	0.9	30.3	0.9
16th “	148.8	2.1	34.2	0.7	34.3	0.7
19th “	155.8	2.3	36.3	0.7	35.6	0.5
26th “	177.3	3.3	41.5	0.7	42.4	0.9
29th “	181.7	1.5	43.4	1.0	46.9	1.5
34th “	197.2	3.1	48.1	0.9	54.1	1.4
42nd “	232.0	4.4	58.0	1.2	61.5	0.9
47th “	—	—	61.9	0.8	64.7	0.4
48th “	254.4	3.7	—	—	—	—
53rd “	263.8	1.9	—	—	—	—

The above results show:

(1) that the oxidation of fresh liquid sewage matters by fermentative processes is slow and progressive; and required many days for completion;

(2) that the effect of dilution was greatly to reduce the rate of absorption of oxygen;

(3) that the rate of absorption of oxygen was similar in the dilutions with sea and with fresh water.

On more closely examining the above results, it will be seen that in all three liquids the rates of absorption of oxygen gradually lessened from the second day to the sixteenth day in the case of the undiluted sewage, and to the nineteenth day in that of the diluted portions. On the twenty-sixth day the rates showed a marked increase in the undiluted sewage, and a decided increase in the fresh water dilution. On the twenty-sixth day to the forty-second the rates increased in all three liquids. On the forty-seventh day it had again fallen in both dilutions; and on the forty-eighth day it had also again fallen in the undiluted sewage.

These variations in the rates of oxygen absorption are to be ascribed to the course of chemical change occurring in the sewage matters during the processes of indirect oxidation. During the first period above noticed, that is, from the first to the nineteenth day of the experiments, the "carbon oxidizable," or "carbon fermentable matters" were undergoing oxidation. During the second period, from about the nineteenth day, the "nitrifiable," or "nitrogen fermentable," matters were being oxidized.

To afford evidence regarding the character of the fermentation changes that occurred in these liquids, while they were under observation, an analysis of the nitrogen compounds in each liquid was made at the commencement of the experiments, and on the expiration of the fifty-third day of observation, with the following results:

TABLE VIII

NITROGEN COMPOUNDS IN THE SEWAGE AND MIXTURES EMPLOYED FOR THE EXPERIMENTS RECORDED IN TABLE VII, EXPRESSED IN PARTS PER 100,000.

	Sewage	Sea Water Mixture	Fresh Water Mixture
At commencement—			
Nitrogen as ammonia	0.825	0.165	0.165
Nitrogen as nitrites	0.0	0.0	0.0
Nitrogen as nitrates	0.0	0.01	0.01
Organic nitrogen	0.675	0.135	0.135
At conclusion—			
Nitrogen as ammonia	0.02	0.0	0.0
Nitrogen as nitrites	0.0	0.14	0.0
Nitrogen as nitrates	0.92	0.0	0.142
Organic nitrogen	0.5	0.072	0.076

The foregoing results show that at the conclusion of the experiments the ammonium compounds in each liquid had been completely nitrified in the two dilutions, and almost completely so in the undiluted sewage. The only difference exhibited by the two dilutions was that in the fresh water dilution the nitrogen fermentation was wholly *nitric,* while that in the sea water dilution was wholly *nitrous.*

A third series of experiments by the writer may be quoted from the Appendix VI, p. 86, to illustrate, in more complete detail, the nature and course of the chemical changes that occur during the purification of a polluted water containing both directly and indirectly oxidizable substances.

Experiments with a Sample of Polluted Water from the Manchester Ship Canal. The sample was a brownish black, turbid liquid, with small quantities of finely divided matters in suspension, including black ferrous sulphide, and emitted an offensive, putrefactive odor. The following experiments were made with the sample:

(1) The sample was first examined after it had been kept out of contact with air for 2 days after collection.

(2) A portion of it, of known volume, was then enclosed in a suitably constructed bottle together with a known volume of air, and was kept for 7 days, when both the air and the sample in the bottle were analyzed.

(3) Another portion of the sample was similarly kept for 14 days and analyzed.

(4) Another portion was similarly kept for 35 days and analyzed.

(5) Another portion was similarly kept for 45 days and analyzed.

(6) Another portion was similarly kept for 60 days and analyzed.

The bottles were immersed during the time of keeping neck downwards in distilled water; the temperature varied between 12 and 16 C. The results which were obtained are recorded in the following table:

TABLE IX

No.	Gaseous constituents expressed in cc., at 0° C., and 760 mm. bar., per 1000 cc. of water									Other constituents as parts by weight per 100,000 volumes of water			
	Dissolved Gases				Atmosphere in Bottles					Nitrogen as—			
					After Fermentation			Before Fermentation					
	Sulphuretted hydrogen	Carbon dioxide	Oxygen	Nitrogen	Carbon dioxide	Oxygen	Nitrogen	Oxygen	Nitrogen	Organic	Ammonia	Nitrites	Nitrates
1	4.16	82.63	0.0	15.33	—	—	—	—	—	0.18	0.8	0.0	0.0
2	0.0	88.46	5.45	14.70	11.55	99.00	506.5	133.86	503.59	0.15	0.88	0.0	0.0
3	0.0	89.77	5.4	14.71	12.2	100.25	535.15	140.86	529.89	0.12	0.9	0.0	0.0
4	0.0	80.25	2.42	14.75	23.20	73.9	544.65	143.28	539.02	0.12	0.0	0.16	0.64
5	0.0	81.39	3.30	14.68	23.7	59.45	491.25	129.34	486.56	0.13	0.0	0.0	0.75
6	0.0	80.45	3.55	15.42	23.85	65.00	513.9	134.91	507.53	0.12	0.0	0.0	0.93

It must be noted that, in the case of these experiments, the bottles and their contents were allowed to remain quiescent during the entire period they were under observation. The figures giving the rates of absorption of oxygen are not, therefore, strictly comparable with those recorded in Tables VI and VII, when the samples were kept continuously shaken with an excess of air—the effect of continuously shaking a sample of over-polluted water with air is, as a matter of fact, to cause a greatly increased rate of absorption of oxygen, and consequently to bring about a more rapid oxidation of both directly and indirectly oxidizable substances in a polluted water.

In all the experiments, the black ferrous sulphide was converted into red oxide of iron in the course of two or three days from the commencement.

For convenience of reference, the quantities of oxygen which were absorbed by the directly and indirectly oxidizable substances, and of the products of oxidation of the latter, during each experiment are separately given in the following table:

TABLE X

Experiment	Gases in cc. per 1000 cc. of water		Products in parts per 100,000			No. of days under observation
	Oxygen absorbed	Carbon dioxide formed	Ammonia	Nitrites	Nitrates	
2	29.41	17.38	0.08	0.0	0.0	7
3	35.21	19.34	0.1	0.0	0.0	14
4	66.96	20.82	—	0.16	0.64	35
5	66.60	22.46	—	—	0.75	45
6	66.36	21.67	—	—	0.93	60

It may be noted that the volume of oxygen theoretically required to oxidize 4.16 cc. sulphuretted hydrogen, when originally present as ferrous sulphide, was 7.28 cc.

It will be seen from the results recorded in the above two tables:

(1) that the whole of the directly oxidizable substances were quickly oxidized relatively to the indirectly oxidizable substances (Exp. 2);

(2) that of the indirectly oxidizable matters the carbon fermentable substances were first fermented, and that the process required at least 14 days for the completion of the process (Exp. 3);

(3) that the nitrifiable matters subsequently required a further 21 to 31 days for complete oxidation (Exp. 4 and 5).

Thus these results, as those already quoted, show that, whilst the oxidation of directly oxidizable substances was rapid, having regard to the conditions of the experiments, and complete in practically one step, that of the indirectly oxidizable substances was progressive, and took place step by step, and required several days for completion.

The writer has had opportunities of applying the lessons to be gathered from the foregoing three series of experiments to the investigation of some typical cases of the fouling of tidal waters by solid sewage matters. The reports of these investigations have been published by the Royal Commission on Sewage Disposal in the Appendix VI to its Fifth Report (see pp. 89-91, 269-303, 325-341 and 380).

Chemical examinations of the tidal waters referred to, viz., the River Liffey, from Dublin to its mouth, the River Ouse, below the junctions with it of the Aire and of the Don, and the River Thames, from London to its mouth, have shown that the deficiencies in dissolved oxygen, from which they severally suffered at the time of investigation, could not be caused by the relatively small proportions of *liquid* sewage matters with which they had been polluted, but that they were to be ascribed to the easily oxidizable sulphides and other products of putrefaction, detached from foul sewage deposits along their beds and diffused through them in the manner already described.

The River Ouse is the most striking of these examples of pollution of waters by putrefactive solid deposits.

The River Ouse, for a great part of its course, where it is fed by the rivers Swale, Nidd, Ure, Wharfe and Derwent, is a fairly clean, natural stream. In spite of some rather considerable pollutions by the sewage of towns and villages, there is nothing in its waters to prevent or destroy fish life. But near Goole, where it is joined by the Aire and the Don, it becomes at times seriously polluted, and it is a matter of yearly complaint that the gross pollution of these streams has not only destroyed fish life in them, but that their dirty waters occasionally poison the waters of the Ouse where they join it and prevent the passage of salmon and other fish trying to ascend from the Humber.

The Ouse, above the point where it is joined by the Aire, drains an area of some 2,630 square miles, and with its chief tributaries comprises a length of stream considerably over 450 miles, nearly the whole of which is available as breeding ground for salmon if they were permitted to reach it. The Aire, with its nearly equal affluent, the Calder, drains an area of 810 square miles, within which lie nearly the whole of the towns, including Bradford, Leeds, Huddersfield and Wakefield, and villages in which the woolen trades of the West Riding of Yorkshire are carried on, as well as many chemical works, collieries, paper works and other premises from which grossly polluting liquids are discharged. The waters of the Aire and Calder, above their junction at Castleford, are grossly polluted by sewage and trade refuse, but between Castleford and Airmyn, near to which the Aire joins the Ouse, a distance of about 25 miles, there is little additional pollution, and considerable purification takes place under dry weather conditions by the deposition of solid sewage matters on the river bed, and by the fermentative oxidation of the liquid sewage matters by water bacteria. The solid deposits are, however, swept out into the Ouse by freshets, and thus that river is most polluted at the time of floods just when salmon are trying to ascend to the upper waters.

The Don drains an area of 682 square miles, within which lies much of the coalfield of the Riding, and in its upper reaches is seriously polluted by the sewage of towns and villages, more especially by the sewage of Sheffield. But the most serious possible pollution, with regard to fish life, is that by the discharge from mines of ochre water, which contains iron in suspension and solution. Between the most polluted stretch of the river and the junction with the Ouse, the river has, like the Aire, a long course in which it receives little further pollution, and in which a similar temporary deposit of sewage solids, and the fermentative oxidation of liquid sewage matters take place.

The Aire empties itself into the Ouse at Airmyn, a place about 5½ miles above the junction of the Don with the Ouse. The banks of the Aire about Airmyn are almost perpendicular, and are covered under high-water mark with a thick, slimy mud. The width of the stream averages about 150 feet at low water, but the mouth of the river is divided into two portions by Asselby Island, around which the Aire waters are held up by the flood tides, and which divides the flow of the waters as they pass up and down the channel.

The Ordnance map, accompanying this Report, shows Rusholme on the Ouse about 1¼ mile above the main mouth of the Aire. From Rusholme to the Don mouth, 6¾ miles, the Ouse varies very considerably in width, being about 800 feet across at the mouth of the Don and 1,700 feet at Howden Dyke Island at high water. The banks of the Ouse are steep and covered below high water mark with clean-looking yellow clay and sand, except after freshets, when they are temporarily discolored by the filth brought down by the waters of the Aire.

The channel of the Don, it may be explained, is artificial; it was made by Vermuyden in 1637, and this portion of the river is locally known as the Dutch river.

The rivers are influenced by the tides for a great distance above Goole; the Ouse for a distance of 27 miles; the Aire and Don 16½ and 17 miles above their respective junctions with the Ouse. The rate of flood and ebb varies very greatly. During spring tides the flow lasts about 2¼ hours, with an ebb of 9¼ hours, and a period of quiescence of about ½ hour at high and low water. During neap tides the flow lasts 4 hours and the ebb 7½ hours.

Dr. Maclean Wilson, Chief Inspector of the West Riding of Yorkshire Rivers Board, made the following tests in order to determine the amount of sea water brought up by these tides: At a spring tide on October 29, 1901, samples were collected at Swinefleet every 5 minutes during the 2½ hours of flow, and every 15 minutes during the ebb of 9 hours. Similarly, at a neap tide on November 4, 1901, samples were taken at the same place every 10 minutes during the flow of 4 hours, and every 15 minutes during the ebb of 7½ hours. The chlorides were estimated, and the following results were obtained:

Spring tide	Parts of Sodium chloride per 100,000
Low water, 5 a.m.	70
6 a.m.	310
7 a.m.	960
7.20 a.m.	1490
High water, 8 a.m.	1400
9 a.m.	1300
10 a.m.	1120
11 a.m.	750
12 a.m.	620
1 p.m.	520
2 p.m.	380
3 p.m.	260
4 p.m.	180
5 p.m.	120

Neap tide	Parts of Sodium chloride per 100,000
Low water, 9.50 a.m.	20
10 a.m.	20
11 a.m.	25
12 noon	60
1 p.m.	150
High water, 1.55 p.m.	370
2 p.m.	400
2.35 p.m.	520
2.50 p.m.	540
3 p.m.	480
4 p.m.	280
5 p.m.	190
6 p.m.	140
7 p.m.	90
8 p.m.	60
9 p.m.	30
10 p.m.	25

Taking the amount of sodium chloride in sea water at 3,000 parts per 100,000, the above figures show that while at the top of a spring tide the water at Swinefleet consists of an equal mixture of river and sea water, at low water of a neap tide there is scarcely any sea water present. At dead low water of a spring tide, on the other hand, there is still a small proportion of sea water present, and at the height of a neap tide there is, roughly, about one-fifth of sea water to four-fifths of river water.

During the spring tide the river rose 12 feet in the first hour of flow, 5 feet in the second hour and 3 feet during the remainder. The first big rush of flood water is therefore practically the flooding back of the waters which have come down during the latter part of the previous ebb, and this is followed by a slower flow with a gradually increasing admixture of sea water. It is apparent from these results that the river water passes several times up and down the river channel before it becomes thoroughly intermingled with the sea water.

In order to show the effect of the waters of the Aire and Don upon the river Ouse, during spring and neap tides, some analyses are quoted in Table XI from the Appendix VI, pp. 330-331. The analyses were made by Dr. Maclean Wilson from samples collected at the following points:

(1) At Rusholme Grange, on the main stream of the Ouse, 1¼ mile above the mouth of the Aire.

(2) In the river Aire, at short and varying distances up the stream.

(3) At Skelton, on the Ouse, 3 miles below the mouth of the Aire, and 2½ miles above the Don.

(4) In the river Don, at short and varying distances up the stream.

(5) At Swinefleet, on the Ouse, 2 miles below the mouth of the Don.

These samples were collected at different tides, spring and neap, at different states of the tide, and, as far as possible, under different weather conditions, as will be seen from the table.

The analytical results recorded in this table are extremely interesting and instructive. On carefully studying them, it will be seen that, while the spring tide samples were more affected by tidal water and consequently contained decidedly smaller quantities of liquid sewage matters than the neap tide samples, they also contained *smaller* quantities of dissolved oxygen. The only possible explanation for this apparently anomalous condition is that the more powerful tidal currents of the spring tides stirred up putrefactive sewage solid matters from the beds of the lower portions of the Aire and Don, and from that of the Ouse, and that these putrefactive matters rapidly absorbed dissolved oxygen from the tidal waters as they became dispersed through them.

As already noted, the waters of the Ouse at Swinefleet rise 12 feet in the first hour, 5 feet in the second, and 3 feet during the remainder of a spring flood tide. A rise of water so rapid must obviously produce an extremely powerful tidal current in the Ouse, Aire and Don immediately above Swinefleet, and one quite sufficient effectively to stir up sand, clay and sewage solid matters deposited during the less powerful currents attending neap tides, and during periods of slack water of both springs and neaps. That such a disturbance of solid matters from the beds of these rivers does in reality take place at flood spring tides is shown by Dr. Wilson's analyses Nos. 37 and 39, Table XI, when they are compared with Nos. 36, 38 and 40. The first two samples referred to were collected at the mouths of the Don and Aire, respectively, and the three last at different and intermediate points along the Ouse. The first two samples contained 685 and 1,093 parts of suspended solids per 100,000, while the three latter contained 421, 648 and 704 parts per 100,000 respectively.

On referring to the quantities of suspended solids recorded in Table XI for neap tide samples collected at the same points along the three rivers, it will be seen that they are much less, varying between 24 and 97 parts per 100,000.

It is evident from these results that the disturbance of the beds of the rivers in the localities referred to is relatively slight at neap tides, and very considerable at spring tides.

TABLE XI

Analyses of Samples of Water Collected from the Ouse, Aire and Don During Different Tidal Seasons, and at Different States of the Tide During September and October, 1901, by Dr. Maclean Wilson.

RESULTS IN PARTS PER 100,000

September 3, 1901 Weather fine Spring tide, 18 ft. 1 in. at Goole

No.	River and Place	State of tide	Solids in suspension	Sodium chloride	Nitrogen as—			Oxygen in cc. per liter*	Remarks
					Ammonia	Albumenoid ammonia	Nitrates		
1	Ouse at Rusholme....	2 hrs. ebb	66.72	211.0	0.014	0.09	0.04	2.00	River calm.
2	Aire at Airmyn.......	2½ " "	186.0	127.5	0.01	0.22	0.05	1.60	River calm.
3	Ouse at Skelton.......	4 " "	238.0	262.5	0.01	0.33	0.04	—	River choppy.
4	Don at mouth........	6 " "	516.6	187.5	0.015	0.64	0.05	—	River choppy.
5	Ouse at Swinefleet....	7 " "	425.0	281.0	0.01	0.53	0.03	—	River calm.

September 17, 1901 Spring tide, 16 ft. 4 in., Goole

Weather, slight drizzle during day, but no heavy rain; water calm.

6	Ouse at Rusholme....	2 hrs. ebb	53.6	262.5	0.015	0.08	0.10	2.50	River calm.
7	Aire at Airmyn.......	2½ " "	365.0	171.0	0.01	0.45	0.0	1.86	River calm.
8	Ouse at Skelton.......	4½ " "	118.0	332.5	0.01	0.07	0.07	2.77	River calm.
9	Don at mouth........	6 " "	516.0	228.7	0.02	0.63	0.07	2.26	River calm.
10	Ouse at Swinefleet....	7½ " "	317.0	310.0	0.0	0.42	0.07	2.67	River calm.

September 23, 1901 No rain, water calm Neap tide, 11 ft. 3 in., Goole

11	Ouse at Swinefleet....	½ hr. flood	60.2	23.0	0.17	0.10	0.22	2.30	River calm.
12	Don ½m. above mouth	¾ " "	24.0	37.0	0.60	0.07	0.19	4.12	River calm.
13	Ouse at Skelton.......	1½ " "	74.8	9.0	0.21	0.13	0.16	3.10	River calm.
14	Ouse at Rusholme....	2 " "	70.6	5.2	0.11	0.14	0.12	4.27	River calm.
15	Aire 1¼m. above mouth	2½ " "	85.6	7.0	0.14	0.14	0.14	3.85	River calm.

October 1, 1901 River very calm, very slight rain during day Spring tide, 19 ft., at Goole

16	Ouse at Rusholme....	2 hrs. ebb	47.0	360.0	0.0	0.06	0.24	1.37	Fine and calm.
17	Aire at Airmyn.......	3½ " "	85.0	265.0	0.0	0.1	0.25	0.97	Calm; slight rain.
18	Ouse at Skelton.......	4½ " "	222.8	465.0	0.0	0.27	0.25	1.92	Calm; slight rain.
19	Don at mouth........	5¾ " "	691.6	360.0	0.0	0.94	0.24	1.58	Tide very fast.
20	Ouse at Swinefleet....	6½ " "	359.4	460.0	0.02	0.56	0.25	1.62	Calm; no rain.

*By Winkler's methods.

TABLE XI—Continued

October 7, 1901 Weather fine, with strong wind. Neap tide, 13 ft. 11 in., Goole

No.	River and Place	State of tide	Solids in suspension	Sodium chloride	Nitrogen as—			Oxygen in cc. per litre*	Remarks
					Ammonia	Albumenoid ammonia	Nitrates		
21	Ouse at Swinefleet....	½ hr. flood	78.0	15.3	0.28	0.15	0.08	4.51	Water very choppy.
22	Don ¼m. above mouth	1¼ " "	73.6	27.0	0.46	0.13	0.14	4.22	Water calm.
23	Ouse at Skelton.......	1½ " "	183.0	14.2	0.37	0.29	0.06	4.62	Water very choppy.
24	Ouse at Rusholme....	2 " "	76.4	8.0	0.37	0.17	0.0	5.30	Water very choppy.
25	Aire 1¼m. above mouth	3¼ " "	74.6	9.5	0.38	0.16	0.0	4.89	Water calm.

October 14, 1901 Weather very fine, but cold, rivers dead calm Spring tide, 16 ft. 4 in., Goole

26	Ouse ½m. above Swinefleet...............	1½ hr. flood	575.0	245.0	0.03	0.84	0.25	1.57	Tide very strong, river rising very rapidly.
27	Don ½m. above mouth	2 " "	663.0	200.0	0.04	0.83	0.23	1.23	Tide very strong.
28	Ouse at Skelton.......	2½ " "	66.8	335.0	0.03	0.11	0.23	2.0	Tide not strong.
29	Aire at Airmyn.......	High water	88.2	110.0	0.05	0.12	0.20	1.01	No tide.
30	Ouse at Rusholme....	¾ hr. ebb	60.0	105.0	0.09	0.09	0.18	1.13	Tide slowly ebbing.

October 21, 1901 Weather cold and foggy, with slight rain Neap tide, 10 ft. 8 in., Goole

31	Ouse at Rusholme....	2 hrs. ebb	11.2	3.7	0.12	0.10	0.06	6.55	River calm and clear.
32	Aire at mouth........	2¾ " "	7.8	4.2	0.15	0.05	0.07	6.63	Tide very low, sample taken just below mouth.
33	Ouse at Skelton.......	3½ " "	31.6	4.5	0.12	0.11	0.07	6.19	Calm.
34	Don at mouth........	4 " "	48.8	6.7	0.15	0.18	0.09	5.85	Calm.
35	Ouse at Swinefleet....	4¾ " "	97.2	8.7	0.07	0.23	0.09	5.29	Calm.

October 29, 1901 Weather calm and fine, no rain on previous day Spring tide, 19 ft. 11 in., Goole

36	Ouse at Swinefleet....	½ hr. flood	421.0	245.0	0.03	0.81	0.10	3.13	Tide very strong, river rising rapidly.
37	Don outside mouth...	¾ " "	685.0	142.5	0.04	1.16	0.08	2.29	Tide very strong.
38	Ouse at Skelton.......	70 mins. "	648.0	115.5	0.04	1.10	0.08	2.27	Tide strong.
39	Aire at Airmyn.......	1½ hr. "	1093.0	45.0	0.06	1.28	0.06	2.12	Tide strong.
40	Ouse at Rusholme....	2 " "	704.0	92.5	0.03	0.94	0.12	2.23	Tide not so strong as at other places.

*By Winkler's method.

As regards the possibility of liquid sewage matters contributing to an appreciable extent to the exceptional deficiency in dissolved oxygen that has been found to obtain in the waters of the Ouse, at spring tides, several reasons may be advanced to show that it is impossible. Thus, on referring to the analytical results recorded in Table XI, it will be seen that the proportions of liquid sewage matters in the neap tide samples were about 10 times greater than those in the spring tide samples, and yet they show less deficiency in dissolved oxygen.

Again, according to the quantities of ammonium compounds shown by the analyses, liquid sewage matters were present in the crude state in the waters of the Ouse in the proportions of about 5 and 0.5 per cent. during neap and spring tides, respectively. But it may be assumed that the organic constituents of the crude sewage had been largely, if not entirely, fermented during their passage from the upper reaches of the Aire and Don to the Ouse. This follows from the descriptions of the incidence of pollution of the Aire and Don, and of the tidal phenomena that obtain in the river above given.

Thus the Aire and the Don, between their most polluted reaches and their junctions with the Ouse, distances of about 25 and 20 miles, respectively, receive little or no further pollution; and the distances along which the Aire and the Don are affected, above their junctions with the Ouse by the tides, amount to 16½ and 17 miles, respectively.

It is evident from these conditions that the liquid sewage matters in question must travel through long distances, several times, up and down the tidal portions of all three rivers referred to, in response to the flow of the ebb and flood tides, before they can escape to the sea, except perhaps when the rivers are in heavy flood, and that they would be subjected to the fermentative processes of an active bacterial flora all the time.

In order to determine the actual character of the liquid sewage matters in question, the writer has on two occasions made an examination of the waters of the Ouse, first in August, 1904, and again in August, 1911. The results which he has obtained are given in the following Tables XII and XIII:

TABLE XII

ANALYSES OF SAMPLES OF THE TIDAL WATERS OF THE RIVERS OUSE AND AIRE, COLLECTED AUGUST 31, 1904. WEATHER FINE. HIGH WATER AT GOOLE 10.17 A. M.[*]

The particulars of collection of the samples were as follows:

	Place of Collection	State of tide	Temp. C.
1	River Ouse just above mouth of Aire	¾ hour ebb	17.0
2	River Aire at mouth	½ " "	17.0
3	River Ouse abreast Howden Dyke, 1½ miles below R. Aire	1 " "	17.0
4	River Ouse just above Goole, 4 miles below R. Aire	1½ " "	17.0
5	River Ouse just above mouth of Trent, 12 miles below R. Aire	2½ " "	17.0
6	River Ouse at mouth of Trent, 12½ miles below R. Aire	3 " "	17.0

Gases expressed in cc., at 0° C., and 760 mm. bar., per litre; other constituents as parts per 100,000.

Sample	At time of Collection			Thirteen days after Collection, the samples being kept out of contact with air							
				Dissolved Gases				Nitrogen as—			
	Sodium chloride	Oxygen	Per cent. saturation	Oxygen	Per cent. saturation	Nitrogen	Carbon dioxide	Ammonia	Nitrates	Nitrites	Organic
1..........	8.3	1.72	24.4	0.47	6.7	14.09	53.33	0.0	0.23	0.007	0.04
2..........	50.0	2.16	30.7	0.52	7.4	14.08	55.09	0.001	0.26	0.0	0.037
3..........	58.0	2.01	28.4	0.29	4.0	14.18	53.85	0.001	0.30	trace	0.035
4..........	207.0	3.60	56.5	—	—	—	—	—	—	—	—
5..........	464.0	4.35	64.2	1.91	28.2	13.57	54.27	0.002	0.25	0.0	0.056
6..........	505.0	4.36	64.8	1.17	17.4	13.46	57.94	—	—	—	—

NOTE. All the samples contained large quantities of brown clay and sand in suspension.
*Quoted from the Appendix VI, p. 336.

TABLE XIII

ANALYSES OF TIDAL WATERS COLLECTED FROM THE RIVER OUSE, ABOUT 1 MILE ABOVE GOOLE, DURING THE EBB TIDE, ON JULY 14, 1911. THE WEATHER WAS VERY FINE AND DRY; THE WIND WAS ALSO CALM. HIGH WATER AT GOOLE 9.34 A. M. SPRING TIDE.

Dissolved gases expressed in cc., at 0° C., and 760 mm. bar., per litre; other results as parts by weight per 100,000.

No.	When and where collected	Temp. C.	When examined	Dissolved Gases			Chlorine	Nitrogen as			Oxygen† per cent. saturation
				Carbon dioxide	Oxygen†	Nitrogen		Organic	Ammonia	Nitrates & nitrites	
1	10.15 a.m., at surface....	21.0	At once....	—	3.2	—	—	—	—	—	54.7
	10.15 a.m., at surface....	21.0	July 24...	56.7	0.9	11.7	101.3	0.05	0.001	0.27	15.4
2	10.20 a.m., 7 ft. below...	20.0	At once...	—	3.7	—	—	—	—	—	64.9
	10.20 a.m., 7 ft. below...	20.0	July 24...	62.9	1.16	11.4	118.5	0.05	0.001	0.23	23.5
3	12.10 p.m., at surface....	21.0	At once..	—	0.9	—	—	—	—	—	—
4	12.15 p.m., 12 ft. below.	21.0	At once..	—	1.9	—	—	—	—	—	—
5	2.15 p.m., at surface.....	22.0	At once..	—	0.8	—	—	—	—	—	—
6	3.0 p.m., at surface......	22.0	At once..	—	1.8	—	—	—	—	—	29.0
	3.0 p.m., at surface......	22.0	July 24...	63.9	0.4	12.42	16.0	0.06	0.003	0.25	6.4
7	3.30 p.m., at surface... .	22.0	At once..	—	0.8	—	—	—	—	—	—
8	4.10 p.m., at surface.....	22.0	At once..	—	0.8	—	—	—	—	—	12.9
	4.10 p.m., at surface.....	22.0	July 24...	62.9	0.4	12.39	8.8	0.05	0.005	0.23	6.5

NOTE. Sample Nos. 1 and 2 contained no nitrites; Nos. 6 and 8 contained decided quantities of nitrites. Nos. 1, 2, 6 and 8 contained 25, 57, 333 and 153 parts of suspended solids (clay and sand) per 100,000; the other samples also contained considerable quantities of clay and sand in suspension.

†These two columns should be read together.

The analytical results recorded in the three preceding tables, when compared together, show that the state of the waters of the Ouse, and of the lower reaches of the Aire and Don, was much the same as far as the degree and character of pollution were concerned, in July last, in August of 1904, and in the autumn of 1901, under similar weather and tidal conditions.

They also show, in the case of the samples that were kept out of contact with the air, that the quantity of dissolved oxygen which each sample contained at the time of collection was much reduced during the period of keeping, and that the ammonium compounds were at the same time reduced to mere traces in quantity. On comparing the quantities in question with those given in Table XI for the spring tide samples at the time of collection, it will be seen that they are from 10 to 20 times less. It may therefore be concluded that the reductions in dissolved oxygen suffered by the same samples on keeping were caused by the fermentation of the ammonium compounds to nitrites and nitrates; and that, consequently, the fermentation of the organic substances originally associated with the ammonium compounds had been effected in the rivers previously to the collection of the samples.

From a careful consideration of all the results given in the three tables, it will appear that the same conclusion holds good for the neap tide samples, under fair weather conditions, except at times, perhaps, during dead low water, when the river waters are practically unaffected by sea water.

Thus it appears that, notwithstanding the enormous quantities of sewage and trade refuse matters that were being discharged into the upper reaches of the Aire, Calder and Don, at the various times the above investigations were made, the polluting effects of the liquid portions thereof upon the tidal waters of the Ouse were not sufficiently marked to render them injurious either to man or to fish life, so long as the weather conditions were favorable to the temporary deposition of the solid matters along the beds of the tributary rivers.

When, however, the weather conditions became sufficiently unfavorable to cause flooding in the rivers, the temporarily deposited solids were dislodged and carried down in a putrefactive condition through the lower reaches of the same rivers, and thence into the Ouse, and they not only fouled the tidal waters of the same for the time being with black, putrid mud, but more permanently fouled their beds.

The conclusion is therefore warranted that had the solid matters been removed from the liquid sewage and trade refuse matters before the latter were discharged into the upper reaches of the tributary rivers, no injury would have been caused at any time either to the tidal waters or to the bed of the Ouse.

This example of the Ouse will perhaps serve as a sufficient illustration of the extremely injurious results which follow the discharge of large quantities of solid sewage matters into tidal waters, the strength and volume of whose currents are not sufficient to dispose of them by transport to open water. Other examples, as already noted, will be found in the Appendix VI referred to.

The discussion of the question with which this Section is chiefly concerned, "The Permissible Limits of Exhaustion of the Dissolved Oxygen in the Waters of New York Harbor," may now be usefully taken up.

There can be no doubt that the waters of New York harbor are being injuriously affected by the sewage solids which are being deposited over the greater portion of its bed. The writer, during a careful inspection which he made of the harbor in company with Dr. Soper, the President of the Metropolitan Sewerage Commission, and with some members of its expert staff, early in October last, found that small masses of black mud were to be noticed constantly rising to the surface of the waters of the more highly polluted portions of the harbor. He found also that very finely divided solid matters were generally diffused throughout the waters of the harbor; they were specially noticeable in the waters of the Upper bay, and were easily traced as far up Long Island Sound as the Stepping Stones Lighthouse. The injury from the accumulation of sewage solids over the bed of the harbor will certainly become more intense in the more highly polluted localities, and more widespread, if the discharge of these matters into the harbor be allowed to continue.

The writer has no doubt whatever that it is easily and directly oxidizable substances from the foul deposits that now cover the greater portion of the bed of the harbor which cause the large deficiencies in dissolved oxygen which have been shown to obtain in the waters of the harbor by the investigations of the Metropolitan Commission.

If therefore a standard is to be formulated with the object of controlling the discharge of sewage matters into the harbor, in the public interest, depending upon the permissible limits of exhaustion of the dissolved oxygen in the waters of the harbor, there must be an antecedent condition that only liquid sewage matters be allowed to be discharged into the harbor, and that all solid matters must be removed as far as possible by mechanical subsidence, or, when necessary in the case of unfavorably situated outfall sewers, which it would be difficult or impracticable to remove, by chemical precipitation.

In fixing the permissible limit of exhaustion of the dissolved oxygen of the tidal waters of the harbor, care must be taken to ensure that, while it does not prevent the legitimate use of the harbor for the disposal of liquid sewage matters, so far as the natural advantages, presented by the harbor for such purpose, permit, it shall safeguard as far as possible the legitimate interests of the great communities residing round the harbor, and shall preserve to them and to the owners of property due consideration for the public health and for the amenities of the great sheets of water comprising the harbor.

Having regard to the favorable nature of the conditions which obtain in those portions of the harbor that are directly affected by the tidal currents for the admixture of river and sea waters, the limit might, in the opinion of the writer, be safely fixed at between 60 and 70 per cent. of saturation, provided that the tests be made at low water, and under calm weather conditions, and at any point not exceeding a distance of 200 yards from the point of discharge, either at the surface or at any depth below it.

Such a limit to the permissible exhaustion of the dissolved oxygen of the harbor waters, in the near neighborhood of the outfall sewers, would ensure, without undue hardship upon the rate payers, reasonable attention to the selection of suitable sites for outfall sewers, and adequate protection to the owners of property and to the amenities of the harbor.

Furthermore, with such a controlling limit to the permissible exhaustion of the dissolved oxygen of the harbor waters, and with the antecedent condition requiring the removal of the solid matters from the liquid sewage matters before the discharge of the latter into the harbor, in force, the general body of the harbor waters beyond the neighborhood of the outfall sewers would in all probability show no appreciable deficiency in dissolved oxygen, not even when, as is anticipated, the volumes of sewage to be disposed of become largely increased with the expected development of Greater New York.

Replies to Specific Questions Put to the Writer, Dr. W. E. Adeney, by the Metropolitan Sewerage Commission of New York.

Question 1. Do you think it would be desirable and feasible to establish a standard of cleanness for the waters of New York harbor?

It would not be advisable, in the opinion of the writer, to establish a *uniform* standard of cleanness for the New York harbor waters—it would indeed be impossible to maintain one in practice.

It must be remembered that the shipping in the harbor constitutes a constant and unavoidable source of pollution, and that the incidence of pollution therefrom is also practically uncontrollable.

Furthermore, as explained in Section III, the harbor waters are quite capable of satisfactorily disposing of the liquid sewage matters from the whole population of Greater New York, and they will be for many years to come, provided that the solid matters in suspension in the sewage be first removed, and that the discharge of the liquid matters be strictly limited and controlled so as not to over-pollute any portion of the harbor waters.

A standard of *minimum* cleanness to which the waters at any point of the harbor may be reduced is, however, essential for the purpose of limiting and controlling the volumes of liquid sewage matters draining into the harbor at any point, and for preventing the discharge of such matters into slack waters.

Question 2. If a standard is established, should it be based solely on chemical analysis or would a mixed standard which would take into consideration the appearance of the water and perhaps its physical, chemical and bacterial condition be better?

It should be based solely upon chemical analysis.

Question 3. Should a standard of cleanness rest upon the amount of sickness and death which can be shown to be produced by pollution, or should the standard be based on what seems suitable and appropriate on the score of cleanness?

The standard should be based on what seems suitable and appropriate on the score of cleanness.

Question 4. Should the waters be kept pure enough for bathing and, if so, where?

For the reasons given in the reply to Question 1, it would at all times be impossible to keep the waters in every part of the harbor pure enough for bathing. It ought, however, to be possible to maintain the waters in those portions of the harbor to which sewage matters in the crude state do not gain direct access in a sufficiently pure state for such purpose.

It is impossible to offer any useful opinion as to the particular parts of the harbor that are, or would be, under the conditions formulated in Section III as necessary for the maintenance of a proper sanitary condition of the harbor, sufficiently pure for public bathing, without having first definitely ascertained the exact chemical conditions of the bed and waters thereof.

Any part of the harbor, the bed and waters of which are free from solid and liquid sewage organic matters in an unfermented condition, and the waters of which contain dissolved oxygen in quantities not less than 80 per cent. of saturation, and ammoniacal nitrogen not exceeding 0.01 part per 100,000, may be regarded as sufficiently pure for public bathing.

It is possible to determine whether unfermented sewage organic matters be present, or absent, in a sample of harbor water by a very simple test.

The dissolved oxygen and ammoniacal nitrogen are determined in the sample while the latter is in the fresh condition. A portion of the sample is also kept in a suitable vessel out of contact with the air for seven days, at a temperature of 18° to 22° C., and the same constituents are again determined. If the dissolved oxygen be found to be unaffected, or reduced by not more than 0.5 to 1.0 cc. per litre, and the reduction of the dissolved oxygen be accompanied by a decrease in the quantity of ammoniacal nitrogen, it may be concluded that unfermented organic matter was entirely absent in the sample at the time of collection.

If, on the other hand, the dissolved oxygen be more largely reduced, and the ammoniacal nitrogen remain similar, or become greater in quantity, it may be concluded that unfermented organic matters were present in the sample at the time of collection, and that the water in question is not sufficiently pure for public bathing.

Question 5. Should the waters be kept pure enough for oyster culture and, if so, in what parts of the harbor?

For the same reasons as those given in the preceding reply, it would be impossible to keep the waters of large portions of the harbor sufficiently clean for oyster culture.

No shellfish industry should be carried on in waters liable to pollution by unfermented sewage organic matters.

Waters of the purity defined in the preceding reply may be regarded as sufficiently pure for oyster culture.

In the case, however, of the examination of waters for the purpose of oyster culture, bacteriological as well as chemical tests should be made, but in reference to the results obtained from them, the writer desires to refer the Metropolitan Commission to the Fourth Report (on Shellfish) of the Royal Commission on Sewage Disposal, England. It will be found that this short report deals as thoroughly with the question of Oyster Culture and bacteriological tests as existing knowledge permits. It must be remembered that oysters have the power of absorbing and concentrating organisms from water, freshly polluted by sewage matters, flowing over them.

Question 6. Should effervescence, marked discoloration, decided turbidity, oily sleek, floating solid sewage materials or deposits of sludge be permitted anywhere in the harbor and, if so, where and under what circumstances?

Marked discoloration and decided turbidity should only be permitted in the immediate neighborhood of suitably situated outfall sewers, as indicated in Section III. Oily sleek, floating solid sewage materials, or deposits of sludge should under no conditions be permitted anywhere in the harbor except to a reasonable extent from the shipping.

Neither should effervescence be allowed.

Question 7. Should we establish one standard of cleanness for the whole harbor, or should there be different standards for different parts of the metropolitan district?

One standard of minimum cleanness should be established in accordance with the requirements explained in the replies to Questions 1, 4 and 5.

Question 8. If a definite standard of cleanness is desirable, how should that standard be expressed? Please give us a draft of your opinion as to the proper wording?

No sewage or refuse matter shall be discharged, or shall be allowed to drain into any part of the harbor except, within reasonable limits, from the shipping, unless the solid matters in suspension therein have been previously removed, as far as possible, by efficient mechanical subsidence or by chemical precipitation when unfavorable local conditions in the vicinity of the outfall sewer require it.

The discharge of liquid sewage matters, from which suspended solids have been previously removed in the manner above described, shall be limited and controlled so as not to reduce the cleanness of the waters of the harbor, at any point not exceeding 200 yards away from the point of outfall, below that represented by a dissolved oxygen content of 60 to 70 per cent. of saturation, and an ammoniacal nitrogen content not exceeding 1 to 1.5 parts per 100,000. The samples for testing shall be collected at low water and during calm weather. They shall also be collected at the surface or from any depth below it.

Question 9. Will the amount of dissolved oxygen in the waters of the harbor, expressed in a percentage of its saturation value, furnish a reliable index of the cleanness of the water, and, if so, what percentage should be adopted to secure each of the following results:

(a) That the waters of the harbor may not become offensive under any weather conditions;

(b) That the use of public baths, if judiciously located, may not be prejudicial to the health of those using them;

(c) That shellfish taken from the beds in present use may be eaten without danger to health?

Reply:

(a) An amount of dissolved oxygen amounting to 60 per cent. of saturation would be amply sufficient to prevent the harbor waters from becoming offensive under any weather conditions, provided that the bed of the harbor were free from pollution with solid sewage matters.

(b) Besides the assurance that the waters of the localities selected for the public baths contain a quantity of dissolved oxygen amounting to at least 80 per cent. of saturation, it is necessary to know that they do not contain unfermented sewage organic matters, and that ammoniacal nitrogen is not present in larger quantities than 0.01 per 100,000. The bed must also be free from pollution from solid sewage matters. (See reply to Question 4.)

(c) Similar information is necessary concerning the waters and bed of the localities in which oyster beds are maintained. (See reply to Question 5.)

SECTION II

REPORT OF CHARLES V. CHAPIN

Metropolitan Sewerage Commission of New York.

Gentlemen: In accordance with your request I made a tour of inspection of the waters of New York harbor in your company on June 28, 1911, and discussed with you a number of problems which are under consideration by your Commission concerning the possible relation of the pollution of these waters and the public health. Later, I received your letter of June 29th, setting forth more explicitly the points on which you desired an opinion. On June 29th I spent most of the forenoon at the Department of Health making inquiries in regard to the sources of the reported cases of typhoid fever. In the afternoon I made a trip to Staten Island, observing the condition of the waters of the harbor and of the water along the piers on the easterly side of the island.

There are four somewhat related topics referring to ways in which the polluted harbor water may have an influence upon health which may be first considered.

1. *The Transmission of Disease by Means of Oysters and Other Shellfish.* Typhoid fever is the only disease which has been definitely shown to be transmitted by oysters, though in the light of our present knowledge there is no theoretical reason why infective diarrhea, dysentery and cholera might not be transmitted in the same way. That well marked outbreaks of typhoid fever have been caused by oysters grown, or "fattened," in polluted waters is established by satisfactory epidemiological evidence. Such an instance of disease due to oysters infected near a sewer in Jamaica bay was reported by yourself in 1904. It is to be noted that in most of these well-authenticated outbreaks the shellfish were infected in water grossly polluted by fresh sewage. There is no doubt that oysters from such waters are a real source of danger. With the progressive dilution of the sewage, and increasing distance from the sewer outfall, the danger diminishes. How much danger is to be apprehended from oysters grown in large bodies of water in which sewage is greatly diluted it is impossible to say. We cannot at present draw the danger line with any degree of accuracy. Outside of

well-defined outbreaks the relation of sporadic cases of typhoid fever to shellfish consumption has been much studied in England and there is considerable evidence to show that a very appreciable amount of the disease is caused in this way. It often appears that typhoid fever is more prevalent among shellfish eaters than among those who do not use them. The Department of Health of New York City has studied this subject somewhat, and from rather meager published figures it does not appear that oyster eaters form an excessive proportion of typhoid cases. Additional figures have been promised me but have not as yet been received. It is, however, difficult to trace oyster infection in a city like New York. In my own city, Providence, conditions are different, for the local market is supplied exclusively from oysters grown in the waters of Narragansett bay, parts of which are grossly polluted with sewage. From the fact that only 10 per cent. of our typhoid fever cases have eaten raw oysters during the incubation period of the disease, and that the disease is far less prevalent when oysters are consumed in the greatest quantity, and is less prevalent among well-to-do people who are the larger consumers of oysters than among the poor, and from the fact that our typhoid death rate is low, I am inclined to think that very little of our typhoid fever is due to oysters, and it is quite likely that the same is true of New York. Efforts have been made by English authorities, and also by those of our own States, to fix a standard of purity for oyster grounds. Such standards must at present be merely tentative. If the impurities allowed by such standards are exceeded, the sale of oysters from the polluted waters should be prevented in some way or the waters should be purified. In such cases the cost of purification must always be considered in connection with the value of the industry. It may be more economical and wiser to destroy the industry than to purify the waters.

2. *The Transmission of Typhoid Fever and Other Diseases by Means of Flies.* This is a subject which has been very widely discussed, but one concerning which there is very little really decisive evidence. On general principles it would appear that the fly, which delights to come in contact with human excreta, and which has often been observed to pass directly from such excreta to milk and other easily infected human food, may easily in this way be the cause of disease. There is an almost universal consensus of opinion that where conditions are especially favorable, as where there are large masses of exposed human excreta, great numbers of flies and unprotected food in close proximity, these insects may be an important factor in the spread of typhoid fever and other diseases. These conditions are realized in army and mining camps, and to some extent in the poorer sections of unsewered cities where privy vaults abound. In well-sewered cities the absence of privy vaults renders the opportunities for fly infection less numerous than in camps. As to exactly what part

of the typhoid fever and diarrheal disease of our cities is to be attributed to the fly is still a matter for investigation and one concerning which there are differences of opinion. I am inclined to the belief that most of the typhoid fever is due to contact infection, to a large extent contact with "carriers," and that the fly does not play a very important part. It has been alleged that in New York the fly has special opportunities for becoming infected on the filth which accumulates along the piers near the sewer outlets. Whether this is so or not, there are other reasons for making such changes in the sewer outfalls as would do away with this source of danger if it be a real one.

3. *The Transmission of Typhoid Fever Through Bathing in Infected Waters.* It has been suggested from time to time that typhoid fever may be caused by bathing in waters polluted with sewage, and alleged instances have occasionally been reported. I know of no instance, however, in which the evidence is at all conclusive. On general principles, again, it may be argued that the danger from this source is very real when the pollution is considerable, as it is along the piers of Manhattan. But the "principles" of sanitary science from which this deduction is made are subject to such unknown limitations that inferences, not otherwise verified, can only be drawn from them with great risk of error. To refer to only one, though quite similar deduction from "general principles," which has been shown to be erroneous, attention is called to the assumption, commonly made a few years ago, that it is as dangerous to use ice cut from polluted water as it is to drink the water itself. There is now abundant epidemiological evidence to show that under ordinary conditions there is practically no danger in using ice from water moderately polluted, but sufficiently so to be highly dangerous for drinking. Bacteriological studies have shown why this is so. It is often assumed that sewage-polluted tidal waters, like those about Manhattan Island, contain many virulent typhoid bacilli, and that bathers frequently, if not usually, swallow very considerable amounts of water, and that, therefore, the danger of infection is somewhat commensurate with drinking similarly polluted fresh water. As a matter of fact, we know really very little about the amount of *dangerous* pollution in New York harbor and similarly polluted waters. It is assumed that the number of virulent typhoid bacilli is fairly indicated by the amount of sewage pollution, or by the number of colon bacilli, or other intestinal bacteria found in the water. But actually very little is known about the number of virulent typhoid bacilli in infected tidal waters, though this is the fundamental fact of the whole matter. It is well known that the problem of determining the danger of infection is a quantitative one. Thus it has been shown that, although pathogenic bacteria may be recovered from sewer air, they occur in such small numbers that the danger of infection from breathing such air is negli-

gible. It may be that the tidal waters around such cities as New York, Providence, Fall River and Boston, where there is comparatively little typhoid fever, are, merely because of dilution, so little infected as not to be an appreciable menace to bathers. It may be, too, that the typhoid bacillus dies, or loses its virulence, in sea-water sooner than we have assumed. Again, it may be that much less water is swallowed by bathers than is commonly assumed. Perhaps the puffing and blowing common with bathers eliminates most of the bacteria which get into the mouth and nose. There may be many other factors which we do not now think of which greatly minimize the danger from bathing in polluted waters. But, however that may be, experience, I think, amply justifies us in being extremely wary of *a priori* reasoning in studying the methods of applied sanitation.

There appears to have been no serious epidemiological study of the danger of bathing in polluted waters, though the problem is an important if difficult one. A study of the relative prevalence of typhoid fever among bathers and non-bathers would afford the best evidence. Though this might not be practicable for the whole number of bathers, an intensive study of selected groups is certainly not impossible. Again, a study of the number of bathers among reported typhoid cases is perfectly simple, and would reveal any large excess among this class. So also a study of age, sex and seasonal distribution of typhoid fever in New York, particularly in comparison with other cities, might throw much light on the subject. At present I am unable to obtain any suggestive data from either the Department of Health or the Superintendent of Baths. You state in your letter that there are over 300,000 baths taken annually in the bath-houses besides those taken along the piers, and if bathing were a serious danger it ought to be reflected in the typhoid death rate. This death rate, however, for the Borough of Manhattan is low, less than half that of the average American registration city. To estimate the danger from bathing in the tidal waters about New York is to make a mere guess, and I do not think that we are warranted from existing data in assuming that it is a very serious one. If this danger is to be a factor of moment in determining the expenditure of large sums for sewage disposal, it ought to receive careful and serious study.

4. *The Transmission of Typhoid Fever from Handling Driftwood.* It has been suggested that the collection of driftwood which floats about the harbor in considerable quantity is a means of spread of typhoid fever. It has been shown that this driftwood is collected by the poorer classes and is carried to their houses when it is used for firewood. I understand, as might be expected, that intestinal bacteria are found on this material. In the light of our present knowledge the handling of this wood is a possible danger. How great this danger is there is no evidence. It is one

of the many modes of "contact infection" in this disease. Contact infection or the fairly direct transfer, usually by means of the fingers, of excremental material from typhoid cases and "carriers" to the mouth and to the food of healthy persons is, I believe, altogether the most important factor in the causation of typhoid fever in cities conditioned as is New York. The reasons for this belief I have elsewhere considered at some length. The hands, unwashed after the use of watercloset and urinal, seem to me to be the most important means by which this disease is spread. Owing to the small number of persons who, I suppose it is safe to assume, handle driftwood, as compared with the number who daily use waterclosets and urinals, and owing to the unfavorable effect of their environment on the life of typhoid bacilli on driftwood, it would appear likely that driftwood, though it may occasionally be the bearer of living typhoid bacilli, is rarely, if ever, the actual source of this disease. A perhaps even greater theoretical source of danger would be the handling of wet hawsers and other lines by deck-hands and wharf men.

In regard to the four modes of infection which have been considered, by which it is possible that the infected waters about New York may be a danger to health, it may be affirmed that we have no accurate knowledge. It is my own opinion that the actual danger at the present time is not very great.

Relation to Health of Odors and Gases from Polluted Waters. This is a phase of the subject concerning which we have far less knowledge than we have of the modes in which infectious diseases are spread. Of late, evidence has been accumulating that what were formerly considered dangerous impurities in air are not so dangerous as was supposed, if they are dangerous at all. Dust certainly has its dangers, and gross pollution of the atmosphere, with odors offensive to the senses, is productive of discomfort which does not conduce to health. Farther than this our knowledge does not at present extend. If the odors arising from the slips and rivers constitute a real nuisance, the nuisance ought to be abated, but we have no knowledge that scarcely appreciable odors, which are only recognizable by sensitive people unaccustomed to them, indicate in any way the presence of substances injurious to health. Such being the facts, the location of many hospitals along the margins of the river adds little weight to the demand for the purification of the waters wherever locally the pollution causes a real nuisance.

It is suggested in your letter that what are commonly called esthetic considerations ought to have weight in any study of river pollution and its prevention. And this is certainly so. The public demands clean highways and it demands clean waterways as well. The degree of cleanliness can perhaps be determined by those who are to pay the bills. To the occasional visitor to New York it appears that the limit of permissible pollution of its waterways has been reached. Odors of sewage may at times be noticed in mid-stream and the waters are evidently discolored and rendered more or less turbid by sewage.

The pollution of harbors and the deposit of sewage sludge on the bottoms take place so insidiously, and the problem of dealing with sewage is so great, that most cities neglect to undertake remedial measures until the waters become extremely foul and the bottoms are covered with a deep layer of gas-forming ooze. Fortunately, New York waters have not yet reached this condition, though they are surely approaching it. It will be well if measures are adopted in time to prevent, instead of waiting to remedy, the enormous nuisance which is certain to develop in the not-distant future.

In passing, it may be suggested that the unattractive appearance of New York harbor is greatly accentuated by floating débris, a large part of which presumably comes from piers and shipping, and which ought to be largely prevented by the enforcement of appropriate police regulations.

Before concluding, I would emphasize what is a fundamental principle of sanitary work, and indeed of public work of every kind, namely, that the value of every procedure must be considered in connection with its cost. This principle, unfortunately, is frequently lost sight of by those who are interested in special projects, and who, realizing their intrinsic importance, fail to remember the large number of other and perhaps equally valid claims on the municipal treasury. It not rarely happens that, owing to lack of careful investigation, or owing to official inertia, or to popular clamor, or other reasons, money is expended for certain sanitary work which, if diverted to other channels, would cause a far greater saving of life and health.

Finally in regard to the pollution of the tidal waters of the City of New York, the dangers to health therefrom, and the action demanded, it may be concluded—

First. That the danger to health from bathing, from the use of oysters and driftwood, and from similar modes of infection, is not sufficiently great nor sufficiently well established to warrant for this alone the expenditure of any very large sums, but if, incident to other remedial measures, it shall be found that the sewage can be freed from pathogenic bacteria at a comparatively low cost it would be wise to adopt such a procedure.

Second. That the discharge of sewers through their present outfalls is productive of many local nuisances of a serious nature and greatly increases the danger of the transmission of disease in the ways above referred to. This local discharge of sewage should be stopped as soon as possible.

Third. That measures should be taken to prevent any further increase in the pollution of the main channels. Where shall be the outfalls of the intercepting sewers which presumably must be constructed, and what sort of disposal works, if any, must be undertaken are matters for experts to determine.

CHARLES V. CHAPIN.

PROVIDENCE, R. I., July 10, 1911.

SECTION III

REPORT OF HARRISON P. EDDY.

METROPOLITAN SEWERAGE COMMISSION OF NEW YORK,
NEW YORK CITY.

GENTLEMEN: In response to your request I have given consideration to the effect of the discharge of sewage into New York harbor and present the following report upon a standard of cleanness for the waters of New York Harbor.

An effort has been made to fix upon such a standard that it is reasonable to expect that the harbor waters can be brought to conform to it and will, thereafter, be maintained in accordance with it and that, if this is accomplished, the waters will be in satisfactory condition.

This study has included an inspection of the waters in question, a discussion with your President of the various conditions affecting the problem, and a review of the report of your Commission, dated April 30, 1910, and other reports and literature bearing upon this subject. Particular attention has been given to the consideration of the specific questions asked by your Commission and by the Board of Estimate and Apportionment, answers to which will be found in the latter part of the report.

WATERS ABOUT NEW YORK.

The City of New York comprises five boroughs—Manhattan, Bronx, Brooklyn, Queens and Richmond. Of these the Bronx is the only one which is not situated upon an island. The main bodies of water bounding the various portions of the city are Hudson river, Harlem river, East river, Long Island Sound, Upper bay, Lower bay, Atlantic Ocean, Raritan bay, Arthur Kill, Newark bay and Kill van Kull. These waters constitute one of the greatest assets of the city, in fact the importance of New York is dependent upon them. It is therefore self-evident that no reasonable expense should be spared to maintain them in condition to satisfactorily perform their important functions.

USES TO WHICH THE WATERS ARE PUT.

These waters are used in many different ways and their very presence has an important climatic effect upon the city and makes life pleasanter on that account. The commerce passing to and fro over these waters is enormous in volume and is destined to increase greatly in years to come. These waters constitute thoroughfares, over and across which millions of people travel each year and when being used in this way may be considered as great water highways.

The City has provided many parks bordering upon the rivers, which in itself is evidence that the waters are valuable features of the recreation grounds. The parks are visited, especially during the warmer months of the year, by great numbers of people who go to them for pleasure, recreation, rest and relief from the turmoil and unsanitary conditions of crowded factories, stores and homes, and who are physically invigorated and strengthened by the fresh air to which they can thus have access. It is of the utmost importance to health as well as comfort that this air be not vitiated by foul odors.

It is common to find large numbers of people standing or sitting in the parks and gazing into the adjacent waters. It is, therefore, important that these waters should be reasonably clean and free from matters which are offensive to the sight.

Further evidence of the value of these waters is found in the fact that public and private hospitals are situated adjacent to them. These institutions, which are provided for the care of the sick, need the best of air and it is obvious that this air should not contain offensive odors arising from sewage-contaminated waters.

A number of public bath-houses have been established along the shores, into and through which the waters pass. These bath-houses are frequented by vast numbers of bathers who should be provided, as far as possible, with clean water free from pathogenic bacteria. There is little direct proof that disease has been caused by bathing in sewage-polluted waters; on the other hand there is substantial evidence which makes it certain that bathing in sewage-contaminated waters must be detrimental to health.

The waters of the rivers are not particularly well adapted for pleasure boating, although there are large numbers of yachts, motor boats and sailing craft which frequent them or which depend upon them, to some extent, to furnish recreation. These interests are entitled to waterways which are reasonably clean, unobjectionable to the sight and free from offensive odors.

The oyster industry appears to have gradually migrated from the waters of the Upper bay and is at the present time confined largely to Jamaica bay and the south shore of Staten Island. There is ample evidence that shellfish, taken from sewage-polluted waters, have caused disease and death. It is therefore important that shellfish should be collected and used for food only from waters which are free from sewage contamination.

Fishing in these waters is a minor industry. However, fish do exist in them and some few are caught. If the waters are seriously contaminated with sewage the fish cannot live in them, and whatever value there is to the industry will therefore be lost.

These waters are doubtless used in many other important ways; enough has been said, however, to show that they constitute an extremely valuable asset to the cities adjacent to them for health and for pleasure as well as for commercial purposes.

General Considerations Relating to Sewage Disposal. At the present time the cities adjacent to the waters surrounding the city of New York and comprising New York harbor and bay discharge their sewage into these waters without removing therefrom any substantial proportion of the inorganic or organic matters. This statement is subject to the qualification that small and relatively insignificant quantities of sewage are treated at a few purification plants.

In considering the question submitted to me, I have taken into consideration the present method of sewage disposal as now in operation in these cities, the conditions produced by the discharge of sewage into said waters and the assurance that the quantity of sewage produced in the future will greatly exceed that discharged into the bay at the present time.

Sewage is made up of about 99.9 per cent. water and 0.1 per cent. of foreign matter, a portion only of the latter being capable of causing objectionable conditions. This relatively small quantity of foreign matter exists in three forms; viz.:

1. Particles having a specific gravity less than that of water, which, therefore, float.
2. Particles having a specific gravity equal to or greater than water, which are carried in suspension in the sewage because of its velocity of flow, and most of which tend to settle in quiescent water.
3. Matters which are dissolved in the sewage or are in colloidal condition.

These substances may be again divided into two classes—inorganic and organic matters. The organic matter, as a rule, is the portion which directly or indirectly is likely to cause objectionable conditions. All sewage contains living organisms, some of which, under favoring conditions, are capable of producing disease.

There are practical methods now in use for removing certain portions of the foreign matters in sewage, and other methods which, while they do not actually remove the organic substances, transform them into mineral or comparatively stable organic matter. These processes are in successful operation, and it must be conceded that it is possible and in most cases practicable to so change the character of sewage before its discharge into tidal or other waters that it will not cause objectionable conditions.

As a rule, the further the process of purification is carried—that is, the higher the degree of purification obtained—the greater will be the cost of treatment. It is, therefore, important to determine to what extent, if any, sewage should be purified before its discharge into natural bodies of water.

Water, whether from the land or the sea, in its natural condition contains a supply of oxygen which is dissolved in it and which is available to support animal and vegetable life, upon which depends the digestion and oxidation of the organic matter of sewage which may be discharged into streams, lakes or the sea. The transformation of the organic matter of sewage into mineral and stable organic matter is brought about very largely by the action of bacteria, and when the quantity of sewage is small in relation to the quantity of water into which it is discharged, the process will go on without materially diminishing the supply of dissolved oxygen. In general it may be stated that there is enough dissolved oxygen in 50 volumes of water to support sufficient bacterial life to transform the organic matter of 1 volume of sewage into stable substances. Many millions of cubic feet of fresh sea and land water pass into and out of New York harbor each day, although it may never be possible to fully utilize it because of the difficulty of securing a uniform mixture of the sewage with the water. It is obvious, however, that the city has at hand a means of digesting the sewage of a large population, and this valuable asset should be utilized as fully as possible, limited, however, by the condition that such use should not unreasonably interfere with the other uses to which the water may be put.

Sources of Pollution.

The sources of littering and polluting substances are many and varied. The natural run-off from the surface of the ground carries with it many substances which affect unpleasantly the appearance of the waters, while the rivers bring down driftwood and the tide brings in drift from the ocean.

By far the most important polluting substances, however, are the waste products from the cities and shipping. The sewers are constantly discharging large quantities of filth, while during storms immense volumes of street washings flow into the waters of the harbor. At times this storm water is very foul, while at other times, especially after the storms have continued for a considerable period, it may be comparatively clean.

In the aggregate the quantities of waste matters which accidentally fall, or are intentionally thrown into the water from the many miles of docks and shore lines, is large. From thousands of boats using the harbor material quantities of sewage are discharged, and considerable refuse, oil and grease unavoidably reach the waters.

EVIDENCES OF POLLUTION

The presence of these foreign substances is made evident by floating matters such as driftwood, casks, boxes, crates, hay, straw, garbage, matches, corks, small quantities of fecal matter, and films of oil sometimes extremely thin and attenuated and at other times comparatively thick and distinctly colored. Occasionally the oil and grease will be driven onto the shore and there spread out over the stones and sand, or cover portions of sea walls and docks. The driftwood either floating upon the waters, or washed up onto the shores, is often covered with oil and grease, indicating that it has come in contact with refuse which, in all probability, came from sewers.

Certain foreign substances, particularly storm water and sewage, produce a marked turbidity, the existence of which diminishes the attractiveness of the waters.

Matters in suspension, such as paper and bits of cloth, are evidences of pollution and as such convey unpleasant impressions to the persons gazing upon the water, whether of necessity, in connection with their occupations or in quest of pleasure and recreation.

Deposits of mud containing sewage matter are exposed at low tide and frequently stirred up by boats in the slips and shallow waters. During warm weather, gas generated in the process of decomposition is seen rising through the water from the deposits below, and often large masses of unsightly mud are brought to the surface, having been made sufficiently buoyant by the entrained gases of putrefaction. Such conditions are obvious evidences of pollution and are recognized as such by the people under whose gaze they fall.

The presence of excessive amounts of sewage or other polluting matters in a given volume of water is accompanied by a reduction in the normal quantity of dissolved oxygen. If this reduction is carried sufficiently far, the water is turned black in color and gives off offensive odors. Unfortunately, such conditions are common in the slips and canals during the warmer weather, and are most unpleasant evidences of pollution.

ILL EFFECTS OF POLLUTION.

Floating Matters. Floating matters give to the waters an untidy appearance, and if they contain garbage or evidences of sewage, such as bits of grease and fecal matter, they are repulsive and objectionable. Police regulations, when made effective by efficient inspection, result in reducing to a reasonable minimum the intentional littering of the waters with refuse and garbage, although it is inevitable that some such substances will find their way into the waters occasionally. Such regulations are, of course, powerless to prevent the discharge of these matters through sewers.

Storm water containing the wash from streets and alleys will carry corks, matches, paper, garbage and many other floating substances which will give the waters in the vicinity of the sewer outlets an untidy appearance. Much can be done to minimize the quantity of such matter by efficient street cleaning. Such discharges are fortunately confined to a limited period of time—practically equivalent to the duration of the storm—and they come at times when the public is least likely to be utilizing the waters and water front for recreation and pleasure. However, the evidences of such discharges will remain for a time—and in some places for a long time—after the cessation of the storms, so that they are not likely to be wholly avoided.

Floating matters are constantly present in sewage, and this is doubtless the source from which the greatest quantity of such substances is to be expected to reach the waters of the harbor and bay if the present method of direct discharge of the sewage is to be continued.

It is entirely practicable to collect the sewage, convey it to suitable points, and there provide means for the removal of the floating matter before it is discharged into the harbor. Such a course seems desirable, although it is doubtful if the removal of the floating matter alone is sufficiently important to warrant so great an undertaking.

Turbidity. One of the important features of the park system is the attractiveness of the water front. Thousands of persons visit the parks largely to secure a glimpse of the water and to enjoy the breezes from it. It will, therefore, be unfortunate to allow the pollution of the waters about the city to proceed so far that they become unsightly or lose their natural cleanness to such an extent that the pleasure of looking into them and observing fish and other animal life is lost. It is, therefore, necessary to avoid excessive turbidity, which is caused by very finely divided suspended matter. Even though there are no recognizable evidences of sewage, the water may become so turbid that the bottom is not visible although the water is of but moderate depth. Such a condition would deprive the people using the parks of one of their natural advantages.

Suspended Matter. Solid substances, as distinguished from those in solution, are carried in suspension in the sewage as it flows through the sewers. Some of these substances are very finely divided and of light, specific gravity so that they do not readily settle even in quiescent sewage. This portion of the suspended matter contributes to the turbidity of the sewage, and of the waters into which it is discharged. Another and larger portion of the suspended matter, because of greater specific gravity or greater size, settles readily in quiescent water, and some of it is so heavy relatively that it will subside even in waters which are moving with substantial velocity.

When sewage is mixed with sea water a precipitation of some of the matters in solution takes place, and the finer suspended matter is carried down more rapidly than in a mixture of sewage and land water. In general, then, it may be said that sedimentation takes place more rapidly in sea water than in land water, and that the sediment is slightly greater in proportion to the total impurities of the sewage.

The suspended substances usually constitute about one-third of the matters in sewage other than water, and a large proportion of them are capable of being deposited on the bed of the rivers and bay wherever the currents are sufficiently slight to permit. Such sludge deposits have been found particularly in the vicinity of sewer outlets located in comparatively quiet waters. The dredgings from the harbor bottom are said to frequently show unmistakable evidences of the presence of matters having their origin in sewage.

About one-half of the suspended matter of sewage is organic—the other half being inorganic in nature. The inorganic or mineral matter is inert and does not enter into the process of putrefaction. The chief objection to it is that it increases the deposits in the harbor and consequently adds to the cost of dredging necessary to the maintenance of suitable waterways. The organic matter varies greatly in character, some being quite stable like paper, while other portions are very unstable, like fecal matter. Both are subject to change, however, and are gradually transformed into mineral matter or into very stable organic substances similar to humus. Such changes are brought about chiefly by living plants and animals.

Wherever these processes of digestion or assimilation take place in the absence of oxygen, they are accompanied by a production of gases and offensive odors. On the other hand, if there is an ample supply of oxygen, the transformation takes place without the evolution of the odors of putrefaction. The complete transformation requires comparatively large quantities of oxygen, and in the case of submarine deposits this oxygen must be supplied from that dissolved in the overlying water. The result is that the supply of oxygen in the water overlying the deposits is greatly depleted and often entirely exhausted.

Oxygen dissolved in water has a tendency to diffuse from portions which are saturated to portions which are not saturated, and from portions of greater to those of a smaller degree of saturation. Thus, the water nearer the surface is robbed of a portion of its oxygen, in order to maintain a supply for that below, which has been or is being depleted by the chemical and biological action going on in the sewage deposits.

If the deposits of sludge are sufficiently extensive the supply of oxygen, which can be provided in this way, may be inadequate for its digestive needs and the whole body of overlying water may become very low in oxygen, if not actually devoid of it. Such a condition is rarely brought about by deposits independent of matters in solution in the water, but deposits are often contributory causes of putrefactive conditions.

In quiescent waters, such as those in canals, slips and small landlocked bays, the supply of oxygen available for the biological process is comparatively small, because of the limited quantity of fresh water, with its supply of oxygen, entering such place with the changes in tide.

Where the deposits are deep, in fact where they exceed a few inches in depth, the oxygen of the overlying water does not penetrate them and, consequently, the biological action is confined to the putrefactive process. This results in rendering soluble more or less organic matter, and the liberation of gases which, when entrained in sufficient quantity, cause large masses of mud to rise up through the overlying water. Thus, the organic matter of the mud is being continuously exposed to the water, and is drawing upon the dissolved oxygen in it to support biological action and complete the process of oxidation. Such upheavals of mud are accompanied by the evolution of gas and offensive odors.

Existence of sewage deposits is objectionable because they are subject to putrefaction, attended by the evolution of offensive odors; because they cause a reduction of oxygen dissolved in the overlying waters, which are re-aerated but slowly, and therefore may themselves become putrid; and because when fermentation is active portions of the mud are carried up into the overlying water, causing turbidity, unsightly floating masses of sludge and the evolution of offensive odors.

Dissolved Matters. About two-thirds of the solid matter in sewage is in solution. Of this, approximately one-half is mineral, or inorganic, and one-half organic in nature. The dissolved organic matter is much more easily oxidized and transformed into inert and unobjectionable substances than the suspended or floating matters.

Due in part to the difference in temperature, and in part to the difference in specific gravity, sewage has a tendency to remain on the surface of sea water when discharged at or near its surface, and to rise to the surface when discharged at a depth. It can even be seen in a comparatively thin layer, from an inch or less to a foot in depth, spreading out over a large area in the vicinity of the point of discharge. A boat passing through such a sheet of sewage will often push it aside, causing it to deepen in a narrow sheet, much as snow will be scraped to one side and be piled up by a plow. Sewage does not tend to diffuse rapidly through salt water, and therefore may cause objectionable conditions when the same quantity of sewage discharged under similar circumstances into land water might be so thoroughly diffused as to be hardly noticeable.

It is therefore necessary to bring about as thorough diffusion of the sewage as possible when discharged into sea water that the surface conditions may not be objectionable. If the diffusion is complete, the entire supply of oxygen in the sea water becomes available for the oxidation of the organic matter, and if the proportion of sewage to water is not too great, the process of transformation into non-putrefactive substances will be one of oxidation and will not be attended by the production of offensive odors.

Nature has provided, as one of the natural advantages of the rivers and bay, an abundant supply of oxygen dissolved in water, which is capable of oxidizing and preventing the putrefaction of vast quantities of dissolved organic matter. *This resource is valuable and should be utilized to the fullest extent compatible with a reasonable enjoyment of the other resources.*

Under all the conditions it would seem reasonable to throw upon the water of the harbor the burden of oxidizing the dissolved organic matters of as much sewage as it can care for, *without materially reducing its value for the other important purposes for which it is used.*

Color. Sewage is normally gray in color and does not impart a marked color to the water into which it is discharged. Occasionally, when containing industrial wastes, it has a very decided color due to spent dye liquors and other substances, and in such cases it may impart a decided color to large quantities of the diluting water. A single industrial establishment may discharge sufficient coloring matter with its wastes to cause such a discoloration extending over many acres of the harbor. It is not known that such coloring of the waters would cause direct damage of any kind. It would not necessarily deplete the supply of dissolved oxygen and therefore might not be a factor in causing putrefactive conditions and it is not necessarily accompanied by offensive or objectionable odors. If it existed at the bathing beaches or in the vicinity of bath houses, it would make the water less attractive for bathing purposes. Boating through portions of the harbor which are highly colored with dyes and chemicals would not be as pleasant as in the same waters in their natural condition. The waters about the shores, especially in the vicinity of recreation piers and parks, should not be so colored as to reduce the pleasure of looking into them.

The discharge of large quantities of coloring matter is generally confined to a few industrial establishments, and the objectionable conditions are usually local and may often be remedied by connecting with sewers serving comparatively large districts. Sewage containing such liquors should be discharged in a manner which will insure thorough diffusion in the water, that there may not be large areas of the bay which are markedly discolored. In some cases it may even be necessary to remove the color by chemical treatment of the wastes before their discharge.

Odor. The facts that hospitals, recreation piers and parks are located close to the waters of the rivers and bay, that hundreds of thousands of persons enjoy their holidays by taking excursions upon the waters, and that great numbers of persons go to the beaches for recreation, are sufficient evidence of the value of the fresh air which they enjoy, or should enjoy at these places. It is obvious that every precaution should be taken to maintain the air in a reasonable state of purity.

Fresh sewage does not usually give off the odors of putrefaction. It may have a soapy or greasy odor which is not pleasant but, on the other hand, is not highly offensive.

The topography of New York is such that the sewers are for the most part comparatively short, so that, taken as a whole, the sewage of the city at the present time is discharged in comparatively fresh condition. While fresh sewage mixed with the sea water in such proportions that there is always an ample supply of dissolved oxygen in the mixture, may impart to the mixture an odor which can be detected by the most exacting tests of the laboratory, such an odor will hardly be noticeable or objectionable to persons boating upon the waters, or to those enjoying the recreation piers and parks. The production of so slight an odor should not prove objectionable.

On the contrary, wherever sewage is allowed to putrefy, offensive odors will be given off and if the harbor receives a sufficient quantity of sewage to use up the supply of dissolved oxygen, offensive odors are sure to be produced. It is obvious that the waters about New York should be maintained so clean that odors of putrefaction will not be produced, that the public may enjoy and profit, to the fullest extent, by the fresh air blowing over the water.

Grease and Oil. One of the most common evidences of the discharge of large quantities of sewage into sea water is the film of grease or oil which is seen upon the surface of the water. While such sleeks often contain bits of solid grease, they are caused by a very attenuated layer of oil which is often distinguishable to the eye at close range with difficulty, if at all. As in the case of other evidences of sewage contamination, the objection to such sleeks is largely a matter of degree. Where they are accompanied by heavy layers of oil, bits of floating grease or other matters which naturally float or are held upon the surface of the water by the film of oil which has coated them, they are objectionable. On the other hand, if they are extremely thin and unaccompanied by floating and visible matters, they may not be objectionable, especially if they cover small detached areas. Such sewage sleeks do not differ materially from fish and seaweed sleeks, commonly seen in some waters.

It is desirable to prevent the formation of a thick scum of oil mingled with bits of grease, fecal matter and other visible evidences of sewage.

In this connection, it should be remembered that some oil and grease is sure to reach waters carrying such extensive traffic of power-driven boats. Engines must be supplied with oil, a substantial portion of which will escape into the water and form surface films of greater or less extent. It is probably impracticable to prevent such contamination.

Bacterial Contamination. The discharge of sewage into sea water undoubtedly increases its content of living organisms, and fortunately so, because upon them largely devolves the burden of the transformation of putrescible matter into stable substances. This advantage is accompanied, however, by the admission into the diluting water of some pathogenic organisms which are capable of communicating disease to human beings.

The existence of danger from this source presupposes the presence in the sewage of disease germs, their admission into the body of the victim and his susceptibility to the inception of the disease. While the necessity of this succession of favoring conditions may appear to render the danger remote, nevertheless it cannot be doubted that pathogenic bacteria are constantly present in the sewage of so large a community and cases of illness attributable to bacterial contamination of sea water are well authenticated.

Bathing in the sea water surrounding the city of New York is very prevalent during the warm season. There are many public bathhouses in which it is stated no less than three million baths have been taken in a single year and this, of course, during the warm months—these bathhouses being open only about three months in the year. Bathing is a very common pastime among boys and young men, large numbers of whom bathe in the slips and at the pierheads along the water front. Perhaps a still greater number of baths are taken at the beaches, such as those of Coney Island and Rockaway, where in a single day hundreds of thousands bathe in the refreshing water of the ocean. It is obvious that water used for bathing purposes, which is taken into the mouth and nostrils, and some of which is swallowed, should be clean and wholesome, although the direct contamination from the bathers themselves is often sufficient to be serious. This latter fact has a direct bearing upon this problem, because it will be idle to attempt to provide natural bathing waters absolutely free from germs when after the first few baths are taken in it, the germ content may be raised materially.

Storm water alone—that is, without the admixture of sewage—will carry immense numbers of organisms into the harbor. The sputum from persons suffering with tuberculosis, the fecal matter of animals and of human beings and many other animal wastes are washed into the harbor in times of storm. If combined sewers are continued in use, these storm flows will carry substantial quantities of domestic sewage as well as storm water. It is thus evident that even if the normal flow of sewage could be diverted from the harbor, immense quantities of germ-containing substances would continue to find their way into the waters. Such contamination cannot practically be prevented and it is probable that the contamination caused by the discharge of sewage from boats, at docks and passing to and fro, will not soon be stopped. It therefore seems certain that the waters about the city will continue to receive large numbers of pathogenic germs. The bathhouses are so constructed that the water in which they are placed circulates freely through them and carries with it the active bacterial life and dissolved impurities which it contains, as well as most of the suspended matter and some of the floating substances, although the latter are excluded to some extent. The bathers are therefore exposed to as great danger when bathing within the houses, as if bathing in the open waters adjacent thereto. It should be pointed out, however, that the bathhouses are located with some degree of care, whereas bathing in the open waters appears to take place regardless of the contamination of the waters by the discharge of sewage.

In view of the certain continuation of the bacterial contamination of the waters about the city, and of the contamination of the waters within the bathhouses by the bathers themselves, it seems clear that steps should be taken to exclude from the bathing pools the natural waters, and to provide water made safe by artificial means. An effort should also be made to encourage the use of the bathhouses and discourage promiscuous bathing in the open waters of the harbor. It is not to be hoped, however, that such bathing will be entirely discontinued and this fact adds another argument in favor of avoiding the excessive pollution of the waters in or near the slips and of maintaining the waters in general in a reasonably clean condition.

The bathing beaches are a very valuable asset to the city of New York. The number of persons visiting the pleasure resorts at Coney Island and Rockaway each summer reaches into the millions and vast numbers of them participate in bathing and wading. This is a refreshing, enjoyable and healthful sport, provided it is not attended with danger of the contraction of disease. Here again the waters are subject to more or less pollution from the bathers, so that too much weight should not be given to the presence of an occasional germ which may have come from the city sewers. It does seem desirable, however, that the contamination of the waters of the harbor and Upper bay should be so limited that they may not be a source of material danger to the bathers at the beaches of the Lower bay, certainly for many years to come, and until the population within the city limits shall have greatly exceeded that of the present time.

Effect of Pollution Upon Fish. Fishing in the waters about New York is a relatively small industry and it appears to be growing smaller from year to year. This is attributed, in some measure, to the presence of sewage in the water and to the danger of bacterial contamination of shellfish. That shellfish may be contaminated by disease germs absorbed from water and may directly communicate these organisms to persons eating them is well proven by numerous investigations. A real danger exists, then, if such food is taken from sewage-laden water, or, indeed, from water in which the quantity of sewage is comparatively small.

But in this case, as in that of the danger to bathers, it seems to be impracticable to avoid some bacterial contamination to the waters about New York. If this is a correct statement of the probable condition, it would seem that some danger must necessarily attend the eating of raw shellfish taken from the harbor. The shellfish industry is confined to the shallower waters and naturally seeks the small bays. These bays are, however, certain to become more or less contaminated by sewage as the population upon their drainage areas increases and as the number of boats traversing them becomes greater. It does not seem possible to guarantee a degree of cleanness in the waters about New York which will ultimately permit the continuance of the shellfish industry with safety.

It is probably true that fishing, especially shad fishing, has been injured by the polluting substances discharged from sewers, manufactories and elsewhere, and it is believed by some that the fish inhabiting these waters have a flavor inferior to those taken from pure sea or brackish water. While it is no doubt desirable that the waters about New York should contain the fish natural to them, the value of the industry and the sport of fishing seem to be too small to constitute an important factor in determining the degree of cleanness which should be maintained.

On the other hand, conditions which are bad enough to drive all fish away may be sufficiently objectionable in other ways to warrant steps being taken to improve the character of the waters to a degree which will enable them to maintain fish life.

Although the data relating to the life of different species of fish in waters of varying degrees of oxygen saturation are not abundant or entirely satisfactory, several researches have been carried out which indicate that the more active species, such as trout and salmon, cannot thrive in waters containing as little oxygen as 25 per cent. saturation, whereas the more sluggish varieties appear to thrive in waters of 50 per cent. saturation and can live for some time if the oxygen is depleted to 10 per cent. saturation. It seems probable, in general, that fish life will continue in waters of 50 per cent. saturation, although the more active species will be likely to avoid such waters and migrate to those furnishing a larger proportion of oxygen.

Dissolved Oxygen. The presence of oxygen dissolved in the waters of the harbor is necessary at all times to prevent putrefactive decomposition and the production of offensive odors. It is not to be expected that the quantity of oxygen in the water will be uniform at all times, because the proportion of sewage and water will be constantly varying and because the demands upon the oxygen present will vary greatly with the temperature of the water. Nor will the per cent. of the saturation value be uniform for the same reasons, and further, because the quantity of oxygen normally present in the water varies greatly with its temperature. It does not, therefore, seem advisable to fix a standard so low that the quantity of oxygen present can never safely, even for a short time, fall below it, but, on the contrary, to establish a standard which shall be applicable under average summer conditions.

The standard should not be based solely upon the necessities of fish life, but upon general considerations, taking into account all the variations which will necessarily exist. In view of all the conditions, it seems that the quantity of oxygen dissolved in the water should not be reduced below three cubic centimeters per liter, this standard to be applicable to any of the waters of the harbor, and based upon conditions at any point and not necessarily upon the average conditions of the body of water under consideration. If such a standard can be maintained, it is probable that the average saturation for the waters of the harbor, taken as a whole and throughout the year, will materially exceed 50 per cent. of the saturation value.

Questions Proposed by Board of Estimate and Apportionment, with Answers

Accompanying your letter dated July 27, 1911, was a list of questions proposed by the Board of Estimate and Apportionment. These questions will be taken up seriatim.

Question: "Will the amount of dissolved oxygen in the waters of the harbor expressed in a percentage of its saturation value furnish a reliable index of the cleanness of the water, and if so, what percentage should be adopted to secure each of the following results:

> (a) That the waters of the harbor may not become offensive under any weather conditions.
>
> (b) That the use of public baths, if judiciously located, may not be prejudicial to the health of those using them.
>
> (c) That shellfish taken from the beds in present use may be eaten without danger to health."

Answer: The amount of oxygen dissolved in the waters of New York harbor, expressed in the percentage of its saturation value, will not alone furnish a reliable index of the cleanness of the waters, particularly with respect to

(b) The use of public baths.

(c) The taking of shellfish for food.

Such a standard might prove satisfactory with respect to offensive conditions, if the Board means by this term to include only offensive odors. If it means to include conditions which are offensive to the sight as well as offensive odors, the percentage of the saturation value is not a reliable index, because floating sewage matters may be present in the water to such an extent as to be offensive to the sight of persons using the parks, working about the piers and boating, while the total quantity of sewage mixed with the water may not be sufficient to reduce the dissolved oxygen below the permissible limit. The percentage of saturation required to prevent offensive odors is hereinafter fully discussed, in the answers to the questions submitted by the Metropolitan Sewerage Commission.

The amount of dissolved oxygen in the waters, as expressed by the percentage of its saturation value, may throw very little light upon the danger to the health of persons using the public baths. In other words, the quantity of pollution may be sufficiently great to create a danger of bacterial infection of the persons bathing in these waters, without reducing the amount of dissolved oxygen below a reasonable standard for preventing offensive odors or even for assuring an abundance of fish life.

The danger in taking shellfish for food from waters into which sewage is discharged lies in the fact that pathogenic bacteria may be transmitted, by means of infected shellfish, to the persons eating them. The quantity of dissolved oxygen in the waters does not indicate their bacterial condition. Obviously, if sufficient sewage is discharged into them to cause the quantity of dissolved oxygen to fall below the saturation value, the practice of taking shellfish for food from such waters must be condemned. On the other hand, the waters might be seriously contaminated with bacteria without causing a marked reduction in the normal quantity of oxygen which these waters should contain. This is doubtless the case in most localities about New York which are suitable for conducting the shellfish industry.

Question. "If the percentage of dissolved oxygen will not furnish a satisfactory standard, what standard would you suggest and should it be based upon chemical analysis, or should it take into account chemical, physical and bacterial conditions?"

Answer. In my opinion a standard which will prove satisfactory and practical must depend upon chemical analyses and observations of physical conditions. If shellfish are to be taken for food from these waters and if bathing is to be continued, such a standard should also be based upon bacterial examinations. These various determinations and observations are hereinafter discussed, so that further comment is not needed at this place.

QUESTIONS OF METROPOLITAN SEWERAGE COMMISSION OF NEW YORK, WITH ANSWERS

Question 1. "Do you think it would be desirable and feasible to establish a standard of cleanness for the waters of New York harbor?"

Answer 1. The waters of New York harbor are of great value to the cities bordering upon them and it is important that they should be kept reasonably clean. Therefore it certainly is desirable that such a standard of cleanness be established if possible. After giving very careful consideration to the location of these waters, to the conditions which have been brought about by the discharge of vast quantities of sewage into them and to the means available for determining the extent of pollution, I am of the opinion that it is feasible to establish a standard of cleanness for the waters of New York harbor.

Question 2. "If a standard is established, should it be based solely on chemical analysis or would a mixed standard, which would take into consideration the appearance of the water and perhaps its physical, chemical and bacterial condition, be better?"

Answer 2. A standard based solely upon chemical analysis will fail to provide adequately for the protection of these waters. It is necessary to take into consideration not only the chemical composition of the waters, but also the quantity and character of floating particles, the films of oil or grease, which are found upon the surface, the effect of coloring matters discharged from the sewers, and the deposits of mud or sludge laid upon the bottom. It is also important to base such a standard in part upon bacterial determinations, provided bathing and the taking of shellfish for food are to continue.

Question 3. "Should a standard of cleanness rest upon the amount of sickness and death which can be shown to be produced by pollution, or should the standard be based on what seems suitable and appropriate on the score of cleanness?"

Answer 3. In answer to this question it may be well to point out the fact that it is impossible to show the amount of sickness and death which results from the pollution of these waters, and therefore too much weight should not be given to such statistics. However, due consideration should be given to these important factors and conditions should be such, and restrictions upon the use of the waters so made, as to reduce to a minimum the danger to health and life.

The waters should be maintained in such a condition that their value for purposes of business, pleasure and recreation can be realized and that they shall be in no way repugnant to the senses. It is probable that if the waters are maintained as clean as such a standard requires, there will be little danger to the public health provided bathing and the taking of shellfish for food are restricted or, if necessary, prohibited.

Question 4. "Should the waters be kept pure enough for bathing, and if so, where?"

Answer 4. As has been pointed out elsewhere, the waters about New York have a value for the oxidation of sewage. If advantage is to be taken of this asset it does not seem likely that it will be wise to encourage bathing in the waters in the immediate vicinity of the city. In other words, the standard should be such that the waters need not be kept pure enough for bathing close to the city. On the other hand, it does seem desirable that they should be maintained in a condition suitable for bathing at such beaches as those of Coney Island and Rockaway. This pastime is enjoyed during two or three months of the summer by vast numbers of people, and it therefore has a real and material value. If the waters in the immediate vicinity of the thickly settled portions of the city are maintained reasonably clean, it seems probable that bathing on these beaches will not be attended by serious danger for many years to come.

Question 5. "Should the waters be kept pure enough for oyster culture and, if so, in what parts of the harbor?"

Answer 5. There would seem to be little objection to permitting the culture of oysters about New York, provided these oysters are not used for food. On the other hand, in view of the fact that infected oysters used for food directly without transplanting are a very ready means of communicating disease to the persons eating them, it does not seem wise to permit taking them from waters which are likely to be contaminated. The great quantity of sewage which now finds its way into the waters about New York would appear to be sufficient to make possible the infection of oysters taken from the water in this vicinity. The value of the oyster industry does not appear to be of sufficient consequence to warrant the expensive works which would be necessary to insure to these waters a sufficient degree of purity to warrant oysters being taken from them.

Question 6. "Should effervescence, marked discoloration, decided turbidity, oily sleek, floating solid sewage materials or deposits of sludge be permitted anywhere in the harbor and, if so, where and under what circumstances?"

Answer 6. The evidences of sewage pollution mentioned in this question, with the exception of the oily sleek, should not exist in any of the waters of the harbor, subject to the qualifications that turbidity and discoloration may be permitted over relatively small areas in the immediate vicinity of properly located sewer outfalls. Oily sleeks resulting from the discharge of sewage may be permitted, provided they consist simply of a very thin film of oil or grease, recognizable only as a sleek and then in isolated and relatively small areas. Thick scum of greasy matters should not be permitted.

Question 7. "Should we establish one standard of cleanness for the whole harbor or should there be different standards for different parts of the metropolitan district?"

Answer 7. To attempt to formulate standards to meet the condition of various portions of the harbor depending upon local conditions, would lead to great complexity, and would be of little practical value because of the constantly changing character of each locality. Districts now residential in character, skirted perhaps by bathing beaches, will undoubtedly give way to the march of commerce and industry, the isolated residences being replaced by blocks and manufactories and the beaches by piers and slips. It therefore seems more practicable to fix upon a single standard which shall represent the *maximum degree of contamination permissible at any point.* The condition of the water will not be the same in all places and for many years portions of the harbor will be in far better condition than those waters which barely come up to the standard which, however, should be such as to make it certain that the optimum value of the water resources can be obtained by the community.

Question 8. "If a definite standard of cleanness is desirable, how should that standard be expressed? Please give us a draft of your opinion as to the proper wording."

Answer 8. A standard of cleanness should be so expressed that it will be possible to determine with reasonable accuracy whether any given body of water is above or below the standard. A standard which in my opinion will prove satisfactory and practicable is given in the following pages:

SUGGESTED STANDARD OF CLEANNESS FOR WATERS ABOUT NEW YORK

Nature of Standard. If it were possible to fix and agree upon a standard of cleanness for the waters about the city of New York, an important step in local sanitation would have been taken. To-day it can be confidently stated that works can be designed which, if properly operated, will assure the maintenance of the harbor waters in a condition which will conform to any reasonable standard.

Standards are often fixed for the cleanness of rivers in terms of the number of cubic feet per second of diluting water, which must be furnished per thousand persons discharging sewage into them, or the number of volumes of water which must be available for diluting each volume of sewage. These standards have given satisfaction when applied to some streams, although in many cases it is not possible to adhere too strictly to them, because of adverse local conditions. In every case they presuppose the intimate mixture of the sewage with the whole flow of the river. Such standards seem inapplicable to the conditions in New York harbor and bay. Here the waters flow back and forth about the city for several days instead of passing constantly by on their way to the ocean as is the case with most inland streams. Furthermore, few if any inland rivers are used to the same extent by so many persons as are these waters.

It would appear wiser, under all the circumstances, to fix a standard in terms of the condition in which the waters should be maintained rather than to arbitrarily designate the volume of sewage which can be discharged into the bay with impunity. This condition cannot be expressed in a single requirement, but should be fixed with due regard to the uses made of the waters and their effect upon the health and happiness of the persons living and spending the whole or a part of their time adjacent to them.

The æsthetic side of the problem should receive due consideration, for into this port come millions of people whose first impressions of this country are gained here. The same is true of a large number of foreign visitors. Certainly the city of New York, as the vestibule to the United States, should present a favorable impression, particularly as one's first impression is often the most lasting one.

A standard to be practicable must be established with a view to the changes in conditions and requirements which will take place during a reasonable period in the future. Such a term would seem to run to the economic limit beyond which it is not wise to now provide works of a capacity sufficient for further growth of the city. This period might well coincide with the term for which bonds for construction purposes should run, and should not be less than thirty years and probably not exceed fifty years.

The importance of giving due weight to probable future requirements is obvious, when the changes of the last thirty years are considered. A generation ago none of the water supplies of this country were filtered and the sanitary inspection and regulation of the catchment areas of waterworks reservoirs was rarely attempted. The crusade for cleaner streets, including prohibition of expectoration upon sidewalks, has had its origin within thirty years. The purification of sewage and the cleaning of ponds, rivers and tidal waters by the exclusion of sewage have come about in this country only within the last three decades.

It is reasonable to anticipate just as great advance in the effort to secure greater cleanness in the next thirty years, as has been made in an equal period in the past. In fact the momentum which this movement has now attained would lead us to believe that the achievements in this direction in the near future will eclipse those of the recent past.

A broad view of conditions as they exist to-day, taken in connection with the advancement of the last few decades and the probable requirements of the next generation, leads to the conclusion that the following requirements constitute a standard which is reasonable and practicable.

It is impracticable to attempt to maintain the waters in their natural condition of purity, in view of the uses to which they are subject, and of the continuous increase in population upon their tributary drainage areas, both of which will inevitably produce substantial contamination.

Floating Sewage Matters. The water should not contain floating sewage matters which are readily recognizable as such.

Grease, Oil and Tar should not be seen floating in thick films upon the water nor should they be discharged in quantities sufficient to cause them to accumulate on the beaches, seawalls, piers or boats. Nevertheless, it is inevitable that small quantities of oil will find their way into the rivers and harbor and the appearance of occasional oily sleeks should be considered as permissible.

Coloring Matters which originate in industrial wastes should neither cause discoloration of the waters near the shore nor for a distance of more than one-quarter of a mile from the point of discharge.

Turbidity may exist but should not be so great along the shore as to prevent the pleasure of looking into the water and easily distinguishing the pebbles on the bottom through a depth of five feet of water upon an overcast day, or the equivalent at points away from the shore, except in the immediate neighborhood of points of sewage discharge. This standard should not be interpreted as applying in times of storm, or immediately thereafter, when the turbidity of the sea water must be temporarily increased.

The suspended matter of sewage should not be present to an extent which will be recognizable to persons in the parks, upon the recreation piers or upon the water, except in the immediate vicinity of the outfalls. It should not form sludge banks which require dredging, or which by the formation of gas give to the water the appearance of effervescence. On the other hand, thin deposits due to exceedingly fine suspended matter or to matter originally found in the sewage in colloidal form may not be practically objectionable. They will not absorb relatively large volumes of oxygen, add notably to the cost of dredging, or be in any way offensive to persons working or seeking health and pleasure about the waters.

Organic Matter in Solution may be permitted provided it is diffused through the wastes and is not sufficient in quantity to exhaust the supply of dissolved oxygen below the standard hereinafter suggested.

Dissolved Oxygen. The quantity of oxygen dissolved in the water at any place should not during any week in warm weather average below 3 cubic centimeters per liter of water.

Limitations of Applicability. In applying the specifications of this standard, the intent of the requirements should govern and a reasonable interpretation should be put upon the various specifications. There is no doubt that it will be possible to find, under any conditions which are likely to exist, certain nominal variations from the standard proposed. If, however, the waters about New York are made to conform to this standard, they will in many places be greatly improved and it is believed that conditions in the harbor will not be objectionable and that the optimum value of the waters can be realized.

Respectfully,

HARRISON P. EDDY.

BOSTON, MASS., October 30, 1911.

SECTION IV

REPORT OF DESMOND FITZGERALD

GEORGE A. SOPER, ESQ.,
President, Metropolitan Sewerage Commission, New York.

DEAR SIR: In accordance with your request, I have made personal examinations into the condition of the waters surrounding the city of New York, and have arrived at a conclusion as to their pollution due to the discharge of sewage into the Hudson river, East river, Harlem river, the Upper bay, the Lower bay, Jamaica bay, and the vicinity of Coney Island and Rockaway beaches. It will be unnecessary for me to describe the nuisances which exist in considerable portions of these waters, this having been already done in published reports. I will, therefore, proceed to answer as well as I can the seven questions which were submitted to me by your Board on the 27th June, and also the eight questions submitted on the 12th July. The following are the questions of 27th June:

QUESTIONS

1. What should be understood by the term "reasonably clean," as applied to the waters of New York harbor?

2. Is it permissible for the sewage to be visible at points of outfall, or elsewhere?

3. Should we allow the water to become so polluted that it is blackened?

4. Should deposits of putrefying and effervescing sludge be permitted to occur among the docks?

5. Should bathing in the waters of the harbor be made safe, so far as disease is concerned, or is this an unreasonably high standard of cleanness?

6. Should shellfish beds be protected against pollution, or should the cultivation of shellfish be given up?

7. To what extent may the sewage be allowed to reduce the dissolved oxygen present in the water in view of the needs of fish-life, and remembering that oxygen is necessary for the mineralization of the organic matter in the sewage?

Answers

1. By the term "reasonably clean" I understand, 1st, as measured by good practice among civilized nations; 2d, the absence of putrefying organic matter in such amount as to produce nuisances.

2. At present points of outfall, or elsewhere in their vicinity, it should not be permissible for the sewage to be visible. If sewage is properly purified, it will not be visible; if not purified, it should be discharged into deep water, sufficiently removed to prevent return upon shores or docks where it might prove offensive or dangerous.

3. The water should not be allowed to become so polluted that it is blackened.

4. Deposits of putrefying and effervescent sludge should not be permitted to occur among the docks.

5. I do not think it practicable to make bathing in the waters of the harbor safe against disease, and I believe this to be an unreasonably high standard of cleanness, but I believe that there are many situations where great numbers of people congregate in the summer, which can be made reasonably safe against disease from bathing, and I believe it to be perfectly practicable to do so. Where there will always be a large floating population on boats, as around and in the docks, water from the mains in the streets should be used in the bathing establishments.

6. Shellfish beds should not be encouraged in positions close to dense population and where it is impracticable to secure a proper purity of the water, as shown by bacterial examinations. The cultivation of shellfish, however, should be protected against sewage discharges in areas sufficiently remote from the center of human activities, and it should not be difficult to draw the line.

7. I am not a chemist and am therefore incapable of giving an answer of technical value as to the permissible reduction in dissolved oxygen in the harbor waters. En-

gineers are, however, often called upon to answer similar questions connected with the sanitary condition of water, and I will make an attempt, as an engineer, to express my views.

In the course of my practice I have never seen so careful an investigation into the dissolved oxygen in the harbor waters as has been made under the direction of your Board, and it seems to me that the results are extremely illuminating and valuable. "In view of the needs of fish-life, and remembering that oxygen is necessary for the mineralization of the organic matter," I think the sewage should not be allowed to reduce the percentage of dissolved oxygen in the water below 50 per cent.

The questions of 12th July are as follows:

1. Do you think it would be desirable and feasible to establish a standard of cleanness for the waters of New York harbor?

2. If a standard is established, should it be based solely on chemical analysis, or would a mixed standard which would take into consideration the appearance of the water and perhaps its physical, chemical and bacterial condition be better?

3. Should a standard of cleanness rest upon the amount of sickness and death which can be shown to be produced by pollution, or should the standard be based on what seems to be appropriate and suitable on the score of cleanness?

4. Should the water be kept pure enough for bathing and, if so, where?

5. Should the waters be kept pure enough for oyster culture, and, if so, in what parts of the harbor?

6. Should effervescence, marked discoloration, decided turbidity, oily sleek, floating solid sewage materials, or deposits of sludge be permitted anywhere in the harbor, and, if so, under what circumstances?

7. Should we establish one standard of cleanness for the whole harbor, or should there be different standards for different parts of the metropolitan district?

8. If a definite standard of cleanness is desirable, how should that standard be expressed?

Please give as a draft of your opinion as to the proper wording.

ANSWERS

1. In any effort to maintain a reasonably clean harbor, some standard must inevitably be formed, though unconsciously, and I think it would be desirable and feasible to establish a standard or standards of cleanness for the waters of New York harbor.

2. In my opinion a standard should not be based solely on chemical analysis, but should be based on a mixed standard which would take into consideration the appearance of the water, its odor and its physical, chemical and bacterial condition.

3. It does not seem to be practicable to base a standard of cleanness upon the amount of sickness and death which can be shown to be produced by pollution. While it is probable that many lives might be saved and ill health alleviated, the question appeals to me strongly from the side of what seems suitable and appropriate under the score of cleanness. The water in a harbor might be so foul as to be unendurable, and yet it might be difficult to reform the nuisance on a basis of statistical health alone. It is a case where civilization demands a remedy on the score of what is necessary for the comfort, happiness, welfare and health of the public.

4. The question of bathing has already been answered.

5. The question of oyster-culture has already been answered.

6. Effervescence, marked discoloration, decided turbidity, oily sleek, floating solid sewage and deposits of sludge should not be permitted anywhere in the harbor adjacent to wharves, docks, bathing beaches, Manhattan front, Harlem and East rivers and other shores. It is possible, however, that appropriate schemes of sewage disposal might involve the necessity for temporary infringement of rules. It will, probably, require a number of years to change the conditions now existing and it would not be desirable to adopt any course which would not distribute the expense over a considerable number of years. No time, however, should be lost in fixing upon a comprehensive plan and beginning work so that the pollution curve may begin to follow a descending line rather than one of rapid increase, which is inevitable in default of wise action.

The above rule, also, must be intelligently applied according as the results of patient investigation prove one plan or another best adapted to the conditions.

7. It seems to me that it would be impossible to establish one standard of cleanness for all parts of the harbor. Even should such a standard be formulated, it can never be attained. I may add, as a result of my investigations, that it seems to me that the best single standard to apply to the general conditions of the harbor waters is the test for dissolved oxygen; but, in taking the dissolved oxygen, it is necessary to use sound judgment, on account of the fact that diffusion takes place slowly in the water, and it is possible that, while a large mass of sewage might, under the influence of the wind, pass over a given section of the harbor, a sample taken beneath the surface, or some distance below the surface, might show only a small diminution in the dissolved oxygen.

8. In providing definite standards of cleanness, for different portions of the harbor, it seems to me desirable that they should be expressed as simply as possible. In the neighborhood of permanent or comparatively permanent beds for the cultivation of shellfish, the standard should be one which is made up largely of bacterial purity. In

the neighborhood of bathing beaches the water should not only be of a high standard bacterially, but should also be free from floating garbage, should have a high percentage of dissolved oxygen, and should be chemically near to the normal condition of pure salt water, or water of the normal salinity, due to its position. In the neighborhood of docks and shores thickly populated, it will probably be difficult to maintain a high chemical standard, and it might, in such cases, be sufficient to provide a physical standard of purity.

According to my views, the situation may be briefly expressed as follows: The whole topographical district should adopt, as soon as possible, a rational and comprehensive system of sewage disposal.

Appended to this report is a copy from my original notes made during the progress of the examinations.

Respectfully submitted,

DESMOND FITZGERALD,
Consulting Engineer.

BROOKLINE, MASS., August 26, 1911.

SECTION V

REPORT OF WILLIAM P. MASON

DR. G. A. SOPER,
President, Metropolitan Sewerage Commission,
New York City.

DEAR SIR: Permit me to reply as follows to the questions recently submitted by you:

1. I certainly consider that it would be desirable to establish a standard of cleanliness for the waters of New York harbor if a reliable one can be secured; but whatever standard is selected, it will have to be used with great judgment.

2. I consider that it would be a great mistake to base such a standard on chemical analysis alone, as I feel that a mixed standard, which would give great prominence to the water's physical condition as well as its chemical and bacteriological conditions, would be far better.

3. I think that a standard based upon the amount of sickness and death produced by pollution would be not only exceedingly difficult to establish but also unsatisfactory for practical use as well. I should greatly prefer to employ a standard based upon what seems suitable and appropriate on the score of cleanliness. The amount of

disease and death directly produced by the influence of the harbor's condition would not, even if accurately determined, be a complete measure of the objectionable features of the harbor's pollution. The measure should be broader than that. Surroundings which offend the senses indirectly lead towards disease by a lowering of resisting power, even as the placing of a patient amid pleasant surroundings aids in the accomplishment of a cure.

Some consideration must be given to the feelings and views of the riparian dweller whose belief is centered upon a close relation between any form of sewage pollution and disease, even though the sanitarian may not fully endorse his views and beliefs from a purely professional standpoint.

There is a direct relation between some forms of filth and disease, even though such relation be not always manifested; and there is an indirect relation between disease and all forms of filth appreciable by the senses, and this latter indirect relation I believe to be the commoner of the two.

The majority of the inhabitants of the cities bordering on New York bay are compelled to remain at home throughout the year, and to them the cleanliness of the bay water, especially in summer, is of material interest. It is a real asset to that portion of the community.

As an agent contributing to the happiness of the people at large, the waters of the bay, if kept attractive, should be considered, as I said above, an asset of the city deserving careful attention. I may add, in this connection, that the wharf line at Boston is markedly better in appearance than what is to be seen in New York. This improved condition is to be credited to the beneficial action of the Boston intercepting sewer tunnel.

4. In my opinion it is not possible to keep the water of any portion of the Upper bay clean enough for bathing purposes, and to my mind the present bath-houses located along the wharves are a menace to health in that by their very presence there they warrant the assumption on the part of the bather that the authorities guarantee the safe character of the water which the baths provide. These bathing establishments should certainly be abolished.

5. In my opinion it would be practically impossible to keep the waters of New York bay north of the Narrows in a sufficiently clean condition for the safe cultivation of oysters.

6. I would reply as follows with reference to the sundry items referred to in this question:

I am not opposed to the presence of oily sleek, for the reason that it is not unsightly and it takes a well-nigh infinitesimal amount of oily material to produce it.

With regard to marked discoloration and decided turbidity, it would be impossible to keep them out of the harbor, for the reason that they are abundantly supplied by the waters of the Hudson river, which carry quantities of such material from up the State.

Floating solid sewage materials, of which I have seen abundant evidence, should not be allowed in any part of the bay; nor should effervescence indicative of bottom putrefaction, such as I observed between some of the wharves, be permitted at any point, for the reason that it would be easy to continue and gradually increase such indications of pollution until the result assumed the character of a nuisance.

7. If an acceptable standard of cleanliness be established, it should be applied with sufficient liberality to permit special points of pollution, such as the outfall from some acceptable sewage disposal plant, to be rated under it without demanding any particular standard for each individual point of pollution. It would be expected that at the immediate outfall of some such plant as here referred to, there could not be an accurate agreement between the bay water there and a sample taken at a reasonable distance therefrom.

8 and 9. I believe that a determination of dissolved oxygen will furnish a valuable standard of cleanliness—perhaps the most valuable—to apply to the harbor waters; but, as I have said above, I do not consider it wise to depend entirely upon the determination of a single analytical item. Physical appearance, more complete chemical analysis, and bacteriological examination as well, should enter into the consideration.

Although I am not prepared to definitely suggest the percentage of saturation value of dissolved oxygen that will furnish a reliable index of the cleanness of the water, I do believe that 70 per cent. is an unduly severe measure whereby to be guided. It would be very difficult to secure analytical figures which shall divide a water likely to become offensive under summer conditions from one capable of withstanding such conditions. The putrescibility test would be the most hopeful to give information upon this point.

As to the use of public baths; I have already covered that point above, and also have expressed my opinion with reference to the cultivating of shellfish.

Yours very truly,

W. P. Mason.

Troy, N. Y., November 29, 1911.

SECTION VI

REPORT OF WILLIAM T. SEDGWICK

George A. Soper, Esq., Ph.D., C.E.,
President, Metropolitan Sewerage Commission,
New York City.

Dear Sir: I have done a good deal of thinking upon the interesting series of questions which you have propounded to me, and while I find it difficult to answer them categorically or in yes and no fashion, I will do my best to give you my opinion as to how they ought to be answered.

1. Standard of Cleanness: Desirability and Feasibility.

I do not think it either necessary or feasible to establish any one standard of cleanness for all the various waters of New York harbor. Provisional standards for different regions would, however, seem to me entirely reasonable, and it is self-evident that a higher standard is desirable and necessary in the slips and on or near the foreshores generally than in the middle of either East or North river or in the Upper bay.

For the very simple reason that many of the foreshores are already crowded, and in the future are certain to be more crowded, with human beings engaged in gainful occupations or seeking the water-fronts for relaxation and fresh air and for bathing or other purposes not involving the use of boats or any considerable stay upon or very near the surface of the waters away from the shores—these last have, it seems to me, peculiar prominence and importance in the sewerage problem, and ought to be kept at the highest possible degree of cleanness consistent with a rational expenditure of money.

For bathing in particular—inasmuch as it will probably always be impossible to prevent extensive bathing, which if it can be reasonably safeguarded from the sanitary standpoint, is from every point of view desirable—somewhat extraordinary measures and expenditures are, it seems to me, justified for the purpose of making the shores and shore waters as clean as practicable. At the same time I do not believe that it will ever be possible to make these same waters along the shores entirely safe for bathing purposes, so that, while I would require a much higher standard for the shore waters than for those in the middle of the streams and in the bay itself, I should not expect to be able to make them always or entirely safe.

Without dwelling at this point upon the particular standard which I would have in mind for these shore waters, or the relation which that standard should bear to that to be applied to the midstreams and the Upper bay, I have, I think, said enough to make it clear that in my opinion it is neither desirable nor feasible to establish any one standard of cleanness for the waters in New York harbor.

2. Chemical, Physical, Bacterial or Other Standards.

In view of my answer to question 1, I hardly need say that no simple standard for the waters of the harbor based on chemical analyses and no compound standard based upon any combination of appearance, chemical and bacterial content appear to me practicable. There are, however, certain obnoxious conditions which should not be tolerated, such as obvious fouling with human feces, the giving off of numerous or large bubbles of gas arising from putrefying deposits, or any similar conditions really disagreeable or disgusting either to the sight or smell of the average citizen using the waters for rowing, sailing or similar pleasure purposes.

3. Standard of Cleanness Based upon Sickness and Death.

Any standard of cleanness based upon the vital statistics of the city would in my opinion be worthless for the simple reason that there is no known relation between the morbidity or mortality of human beings and the purity or impurity of the waters upon which or near which they may dwell. Any standard based on "what seems suitable and appropriate on the score of cleanness" would also have little or no value because opinions would differ so widely as to just what is "suitable" and "appropriate."

4. Purity of Waters for Bathing.

I have already intimated in my discussion of question 1 that I do not consider it possible to keep the waters of New York bay along the shores under any system whatsoever ideally pure for bathing. By this I mean that I do not consider it possible to sterilize the waters of New York harbor at all places and at all times by any procedure. This point hardly requires discussion because it is evident to any sanitarian that waters subjected to such uses as those of New York must always be subjected to, and exposed to such infections as those waters must always be exposed to, will never be in the strict sense of the words "pure enough" for bathing purposes. By the word *shores* in the above statement I refer to the shores of the Upper bay and especially of the more populous portions. Those of Coney Island and at certain other points which might be selected for the purpose can, on the other hand, and should be kept scrupulously clean and practically free from sewage, so that they may be used practically with impunity for bathing purposes.

At the same time, I have no doubt that the waters of Upper New York bay, and especially the waters of the docks or slips and of the foreshores of the more populous districts of New York, Brooklyn, Jersey City and the like, will always be extensively used for bathing purposes. The tropical summers to which New York is exposed will probably always make it impossible to keep boys and other persons from bathing in vast numbers in the waters aforesaid at many places and at many times, and this I believe to be a fact with which we must frankly deal.

Assuming then that the waters under consideration cannot be kept ideally pure for bathing purposes, and also that in spite of this fact they will undoubtedly be largely used for such purposes, it seems to me that the best that can be done is to keep all possible raw sewage out of the slips and docks and away from the foreshores. This I would do either by removing all sewage from the waters of the bay or else by so introducing sewage into those waters that it shall do no great harm.

It seems to me that while it will for years to come be impracticable because too costly to remove all sewage from the harbor waters, it will be possible to so reduce the amount of sewage poured in, and to so locate the sewer outfalls that whatever sewage is allowed to enter shall do no great harm.

To the discussion of this last point I shall return beyond.

5. Oyster Culture in the Harbor.

I do not consider oyster culture in the waters of New York harbor to be of sufficient importance to require any special degree of purity in those waters. It is with oyster culture very much as it is with bathing: no matter how pure the waters of the harbor are made or kept, accidental pollutions from ships and other uncontrolled sources will always forbid the use of the harbor as a proper place for the cultivation of any food which is to be eaten raw. Moreover, the economic importance of oyster culture for or by a small number of persons is not to be weighed for a moment against the economic interests of thousands and perhaps millions of riparian residents.

6. Effervescence, Discoloration, Floating Matters, Deposits, Etc.

I am of the opinion that the existence of "effervescence, marked discoloration, decided turbidity, oily sleek" and "deposits of sludge" may at certain times and certain places be contemplated without danger to the public health and without serious injury to the use of the harbor for commercial or pleasure purposes. As for "floating solid sewage materials," I have a different opinion, believing as I do that these ought to be either screened out or broken up before the substances of which they are composed are admitted to any portion of the harbor.

As to the places and circumstances under which effervescence and the like should be permitted to exist, I shall have something to say further on.

7. One Standard or Different Standards.

I believe it to be quite impossible to establish any one standard or ideal of cleanness for the whole harbor and that there should be different standards or ideals for different parts of the Metropolitan District.

8. Definite Standard, Dissolved Oxygen, Etc.

Inasmuch as I have stated in question 1 that I do not believe it either practicable or necessary to have any one definite standard of cleanness, I am of course relieved from the necessity of describing that standard or of giving a draft of the wording of it.

I do not believe that the amount of dissolved oxygen in the waters will furnish either a complete or a satisfactory index of the cleanness of the waters, or even of their digestive capacity, at all times and places and under all conditions. I do, however, believe it to be a valuable index, which should be one important element in the formation of an opinion as to the actual degree of cleanness or uncleanness, and as to the digestive capacity, of any particular water at any particular time.

Having made the foregoing statement, I am, I think, relieved from any discussion of (a), (b) and (c).

But although I do not believe that any rigid physical, chemical or bacterial standards are either practicable or desirable, I do believe it practicable, and that the aim should be to keep the waters of the docks and shores so pure that the health and the comfort of those using them or living near them shall not be seriously threatened, while still utilizing the central portions of the rivers and bays for the disposal of such an amount of sewage—and this may be large—as shall not seriously interfere with navigation or with their use for pleasure purposes, such as boating and sailing.

I wish that it might be possible for your honorable Board to convince the people of Metropolitan New York, as I am convinced, that no investment, however great, would be too large to secure the complete and perpetual conservation of these waters for purposes of health, of pleasure and of agreeable and attractive commerce. Nor is this condition merely an iridescent dream. A sum such as is already set apart for clean, pure, drinking water for the metropolis would go far toward making this a reality; and I hope you will understand that while in answering your questions, I have tried to tell the truth as to the possibility of the disposal of the sewage into the adjacent waters without the creation of an intolerable nuisance, I am of the opinion that any such disposal should be regarded as merely provisional and temporary; the ultimate solution of the problem before you being the complete and total removal of all sewage and other polluting materials from the harbor waters.

Very respectfully yours,

Boston, Mass., November 7, 1911.

W. T. Sedgwick.

SECTION VII

REPORT OF F. HERBERT SNOW

George A. Soper,
President, Metropolitan Sewerage Commission of New York,
17 Battery Place, New York City.

My Dear Sir: On July 28th you requested me to give a written opinion concerning the degree of cleanness suitable to New York harbor and mentioned ten points upon which you were particularly desirous that specific answers should be made.

The ten propositions are herein re-stated and each in turn is followed by my answer.

Question 1. Do you think it would be desirable and feasible to establish a standard of cleanness for the waters of New York harbor?

Answer. Yes, desirable from general considerations of public health and welfare to establish standards rather than one general standard. Lack of such standards has not only resulted in numerous local odor nuisances that one may not escape at slips and basins and coves, but the lack renders it possible for one to detect the proximity of the city through the sense of smell on approaching by water from the ocean.

Vitiated atmosphere is especially abominable at the hospitals and parks and recreation piers located along the water front. Furthermore, it is incredible that disease and death are not the direct results of bathing in the harbor. A thorough systematic investigation of this subject and of disease resulting from the eating of sea food taken from sewage-polluted waters would prove the great danger in such practices and establish the necessity from the standpoint of public health for the control of the cleanness of the harbor.

But it is the offense to the sense of decency to which I would attach the greatest significance; an offense apparent throughout the metropolitan district in the vicinity of sewer outfalls and along the foreshores.

Values of various kinds are adversely affected in consequence of the existing methods of sewage disposal. In the aggregate the result is of no inconsiderable moment. New York City is envied the world over in its possession of a wonderfully extensive and diversified water-front. But no metropolis, however well favored, can neglect her greatest resource and long retain an enviable reputation.

The situation is one to be appreciated in particular by those who have investments under control, whose exercise of choice constitutes the motive power of enterprise. To such men of affairs the value to which I refer is a real thing apparent and potent where competition exists in all matters worthy of emulation between localities, communities and cities. It is the value of a satisfactory standard as distinguished from that of an unsatisfactory standard.

Already higher standards of harbor cleanness have been adopted at not a few of the great ports of the world. And this sense of what is desirable should be sufficient consideration alone to compel a change and improvement in sewage disposal methods and dictate standards of cleanness for the waters of New York harbor.

Question 2. If a standard is established, should it be based solely on chemical analysis or would a mixed standard which would take into consideration the appearance of the water and perhaps its physical, chemical and bacterial condition be better?

Answer. The standard should not be based solely on chemical analysis of the waters because it is not desirable, since other factors are essential. If the sewage of the city were to be collected at one point and it were there to be uniformly distributed through the waters of the harbor, even then a chemical standard would be insufficient. Hence, with conditions of sewage dispersion attainable at different places in the harbor, it would be absurd to establish a chemical standard for the whole harbor as the basis for the cleanness of the waters in the several parts of the harbor. However, chemical tests are invaluable as an aid in determining the kind of sewage works essential to install to relieve some parts of the harbor of an overburden of sewage waste and to obviate such overburdening in other parts. The value of a chemical standard is supplemented and is reinforced by other standards.

A bacterial standard alone would also be impracticable for the harbor as a whole. The points of collection could not be so selected as to produce results admitting of satisfactory interpretation in my opinion.

Question 3. Should a standard of cleanness rest upon the amount of sickness and death which can be shown to be produced by pollution, or should the standard be based on what seems suitable and appropriate on the score of cleanness?

Answer. Considerations of public health are of paramount importance and no lower standard should be established. However, to trace the amount of sickness and death resulting from pollution of New York harbor waters would be a difficult undertaking involving the employment of a large number of special inspectors and the expenditure of a very considerable sum of money. After the facts were ascertained they would prove really immaterial, since the practical remedy would be the same in all events. That is, within the bounds of what it is reasonable to do in abating nuisances and preventing their recurrence, in disposing of the sewage of the metropolitan district in a manner that shall not offend the sense of decency, or depreciate the value of shore property, or interfere with the uses of the waters for bathing where it is eminently fitting that bathing should be maintained, the interests of the public health would also be subserved.

Question 4. Should the waters be kept pure enough for bathing, and if so, where?

Answer. Yes, most assuredly, in some sections of the metropolitan district.

In that part of the boroughs of the Bronx and Queens bounding the upper stretches of the East river and the entrance to Long Island Sound, where the shores are deeply indented by bays—Flushing bay being prominent—and small estuaries abound, the waters should be kept pure enough for bathing.

Also in that part of the boroughs of Richmond and Brooklyn lying below the Narrows, including Gravesend bay, the waters about Coney Island and the southern shores of Queens along the outer harbor and Jamaica bay, the waters should be preserved in their natural purity if a great and essential resource is to be retained for the well-being of the public.

It is none too soon to begin the plan of conservancy. Ten millions of people will inhabit the metropolitan district one generation hence.

In fact, the discharge of crude sewage into any water within the district cannot be attempted to-day without serious risk of a nuisance being established thereby; and such disposal into the waters specifically mentioned above, without offense, has become impossible.

In my opinion, to restore the waters surrounding Manhattan borough to a sufficient purity, and then to keep the waters pure enough to render bathing in them safe, is impracticable.

The maritime people who frequent the bath-houses, piers, wharves and bulkheads in hordes, and swim in the sewage-polluted waters, find this art essential to their existence. Not only is it educationally important, but from the health standpoint it is even more important that the city should provide and maintain free bathing establishments. Observations made during the extraordinary protracted heat period of last summer alone should prove the necessity in a great city like New York for ample bathing facilities.

No system of policing to keep the multitude out of the filthy waters of the harbor can be successful until equally convenient, commodious and safer facilities be substituted. This I conceive to be a pressing public duty.

Question 5. Should the waters be kept pure enough for oyster culture and, if so, in what parts of the harbor?

Answer. Oyster culture ought not to be permitted anywhere within the metropolitan district except under strictest supervision and control. It is not feasible to keep the waters of the harbor pure enough to warrant a general guarantee of safety to the public in eating raw shellfish taken from such waters.

On board ocean liners water for bath-tub purposes is obtained from the sea. Intelligent passengers recognize the fitness of the rule which prohibits a bath on the last day of the voyage when the ship is in the outer bay. If these waters be not desirable for the bath, surely they should be less desirable for oyster culture. The traffic in shellfish harvested in the outer waters of the lower bay might be permitted for the present provided every shipment were examined and certified by competent authority to be free of pollution.

Question 6. Should effervescence, marked discoloration, decided turbidity, oily sleek, floating solid sewage materials or deposits of sludge be permitted anywhere in the harbor and, if so, where and under what circumstances?

Answer. The very least that could be done in making any substantial improvement over existing conditions of harbor pollution would be to remove the suspended solids of animal origin. This accomplishment would obviate sludge accumulation and consequent effervescence.

The next step, if the improvement is to be considered by stages of development, would be to further relieve the air over the waters of its surcharge of noxious gases by thoroughly diffusing the screened or preliminarily treated sewage throughout a large body of moving water to assure the greatest degree of dilution and oxidation.

This accomplishment would be accompanied by the elimination of marked discoloration and turbidity; but whether the odors would be obviated would depend upon whether the water were sufficient in quantity and quality to take care of the volume of sewage so dispersed.

The primary objects of any plan should be, first, the prevention of sludge accumulation in the harbor; second, the elimination of marked discoloration and turbidity; and third, the reduction to the minimum of oily sleek—for where there is much oily sleek on the surface of the water there will be odor.

Question 7. Should we establish one standard of cleanness for the whole harbor or should there be different standards for different parts of the metropolitan district?

Answer. The maintenance of a standard involves the construction of works to control the polluting factors. These factors are variable for a given territory. Furthermore, they are not the same for different territories. There is a wide range of control to be effected if the things hereinbefore proposed are to be accomplished in the harbor.

It is not essential, in my opinion, that all of the sewage of the metropolitan district should be collected at one point and there disposed of. A more desirable and economical plan is to solve the problem by sub-districts in which the factors are adapted to control in works of a certain type. For example, where preliminary treatment of the sewage to remove the suspended matters prior to diffusing the liquids throughout a predetermined volume of water is best suited to the requirements, the problem is solved for that territory. Where more extended treatment is demanded, the results can likewise be predetermined by the type of works selected.

The point I wish to emphasize is that the type of works, the capacity of the plant and its effectual operation will have more to do with the condition of the cleanness of the harbor than all other standards put together. I would, therefore, make the type of sewage disposal works the prime factor in a standard. The plans should be submitted to the proper authority for approval, their execution should be under the supervision of such authority and so also should the operation of the works thereafter.

A standard of performance should be set for each outfall works. Here control can be exercised and not elsewhere. Observations for efficiency of operation would include chemical and bacterial analyses and physical conditions as the case might be.

Question 8. If a definite standard of cleanness is desirable, how should that standard be expressed? Please give us a draft of your opinion as to the proper wording?

Answer. The plans for each sewage works, as designed or approved, or modified, or amended by the Commission or proper authority existing for the purpose, should be certified to the local authorities for execution, under such conditions and stipulations as will keep the responsible supervisory control of all essential matters with respect to construction, operation and maintenance in the hands of said Commission or proper authority.

Daily records of operation of each plant should be required, and if at any time, in the opinion of the controlling authority, the works or any part thereof, or the efficiency of the same be insufficient, or below standard, or prejudicial in any manner, then such remedial measures as the case may demand should be adopted forthwith. The controlling body should be vested with plenary authority to enforce its decrees.

In addition to the foregoing queries, you have transmitted for my consideration and answer the two following questions, which have been proposed by the Board of Estimate and Apportionment, concerning a standard of purity for the waters.

Question. Will the amount of dissolved oxygen in the waters of the harbor, expressed in a percentage of its saturation value, furnish a reliable index of the cleanness of the water and, if so, what percentage should be adopted to secure each of the following results:

(a) That the waters of the harbor may not become offensive under any weather conditions.

(b) That the use of public baths, if judiciously located, may not be prejudicial to the health of those using them.

(c) That shellfish taken from the beds in present use may be eaten without danger to health.

Answer. The necessity for treatment of the sewage discharged into the upper harbor is not established by chemical or bacterial examination of the waters. It is flagrantly announced to the natural senses.

From the scientific standpoint the degree of the pollution can be judged best perhaps by the dissolved oxygen test. The extensive data collected by the Commission furnish a reliable index, from the scientific standpoint, of the limit to which sewage can be absorbed by the harbor waters. Practically, the limit is reached and a remedy is demanded. Theoretically this limit may be extended. The said dissolved oxygen data in the possession of the Commission are an acceptable basis upon which to predicate the design of sewage works where it is the intention to utilize the natural oxidizing capacity of the harbor waters to accomplish the greatest part of purification; but elsewhere other considerations should obtain.

As before stated, in my opinion, it would be a mistake to accept the dissolved oxygen standard alone as a basis upon which to maintain the sewage disposal works after they are built.

My answer to proposition (a) is that to prevent the waters of the harbor from becoming offensive under any weather conditions, less crude sewage must be discharged into them than at present. I would not express this in terms of dissolved oxygen as a standard. Whether or not the object for which the sewage works is built at any point is being attained should be a matter for judgment based on observation of facts obtaining at the time.

My answer to proposition (b) is that public baths should be supplied with pure water.

My answer to proposition (c) is that shellfish are a public menace if taken from waters containing sewage organisms. The bacterial test, not the chemical test, is applicable if certificates of purity of the product harvested from doubtful waters are to be issued.

A dissolved oxygen standard with respect to bathing waters and shellfish culture would mean the holding in jeopardy of public health in my opinion.

Question. If the percentage of dissolved oxygen will not furnish a satisfactory standard, what standard would you suggest, and should it be based upon chemical analysis, or should it take into account chemical, physical and bacterial conditions?

Answer. Chemical or bacterial tests alone are not a practical basis for a standard. They are supplementary in character rather than primary, as hereinbefore explained. The control of the pollutions depends upon the kind of works provided for the purpose and the effectual operation of the works.

Respectfully submitted,

HARRISBURG, PA., September 28, 1911.

F. HERBERT SNOW.

SECTION VIII

REPORT OF C.-E. A. WINSLOW

Dr. George A. Soper,
Metropolitan Sewerage Commission,
17 Battery Place, New York.

Dear Dr. Soper: I have given careful consideration to the very comprehensive questions enclosed in your letter of September 13th and have answered them serially below in accordance with the knowledge at my disposal.

1. Do you think it would be desirable and feasible to establish a standard of cleanness for the water of New York harbor?

From a purely scientific standpoint arbitrary standards are unfortunate, for they always break down when applied to such complex problems as those of modern sanitation. On the other hand, it is almost essential for practical purposes to formulate principles for the guidance of administrative action. In connection with the matter in hand, the cleanness of the waters of New York harbor, I do not believe it is desirable or feasible to establish any arbitrary standards in the form of a published enactment to be rigidly enforced. I do believe it is desirable and feasible to formulate standards which may serve as guiding principles to be intelligently interpreted in the light of all available knowledge in individual cases. Such standards should differ, however, for different regions of the harbor as indicated below.

2. If a standard is established, should it be based solely on chemical analysis or would a mixed standard which would take into consideration the appearance of the water and perhaps its physical, chemical and bacterial condition be better?

Chemical analysis would not, in my judgment, furnish a sufficient criterion of the condition of the harbor waters. In portions of the harbor necessarily subject to considerable pollution it should be supplemented by observations of physical conditions and appearance and in the regions which can be kept reasonably pure it should be supplemented by bacteriological examinations.

3. Should a standard of cleanness rest upon the amount of sickness and death which can be shown to be produced by pollution or should the standard be based on what seems suitable and appropriate on the score of cleanness?

I think it would not be feasible to base any standard on the amount of sickness and death shown to be produced by pollution, as definite evidence of the actual effect upon health of such conditions as exist in New York harbor is not available. Standards for those regions of the harbor which may reasonably be expected to be clean enough for bathing and the taking of shellfish should, however, take into account the probability of danger to life and health, and should be primarily sanitary in nature, while those applied to those regions which must necessarily be more or less polluted should be chiefly esthetic and should look to the avoidance of offensive and unsightly conditions.

4. Should the waters be kept pure enough for bathing, and, if so, where?

5. Should the waters be kept pure enough for oyster culture and, if so, in what parts of the harbor?

It is, in my judgment, not feasible to keep the Upper bay, from Spuyten Duyvil on the Hudson and from Hell Gate on the East river to the Narrows, and including the Harlem and Newark bay, in a safe condition for bathing and the cultivation of shellfish. The data collected by your Commission indicate that these waters contain on an average only between one-half and three-fourths of the oxygen necessary for saturation and show average bacterial counts of between 6,000 and 15,000 bacteria per cubic centimeter. This indicates a condition of considerable pollution and I do not believe that any practical measures of reform will decrease this pollution sufficiently to eliminate the sanitary danger to those exposed to the ingestion of the water. In my opinion the use of these waters of the Upper bay should be definitely abandoned for bathing and the cultivation of shellfish. Under the head of shellfish I should include not only oysters but clams as well, since many of the processes of cookery to which these animals are subjected are insufficient to destroy the germs of contagious disease. It may prove that certain special areas in the Upper bay are so protected from pollution that their waters may safely be used for the purposes designated; if so, they should be excluded from the general principle stated.

The waters of the Lower bay, outside the Narrows, can, I believe, be kept clean enough for bathing and oyster culture and should be maintained so far as possible in that condition. The records of your Commission indicate that these waters contain over 90 per cent. of the dissolved oxygen necessary for saturation and that the average bacterial numbers range between 1,000 and 5,000 per cubic centimeter. With the enforcement of proper local regulations it should be possible to so purify these waters as to make them suitable for the purposes under discussion. As in the case of the Upper bay, there may, of course, be particular localities which should be exempted from the general rule. Jamaica bay offers a special problem more difficult of treatment. At present it appears from your reports that the water of this bay is as polluted as many parts of the Upper bay around Manhattan Island (76 per cent. of dissolved oxygen necessary for saturation and 5,800 bacteria per cubic centimeter). It may ultimately be necessary to sacrifice this landlocked bay to the purposes of sewage disposal, as it has been necessary to sacrifice the East river and the Hudson. I do not believe, however, that this should be done without a thorough study of local conditions and a determined effort to apply all the resources of sanitary science, including the possible use of disinfecting plants, to the end that Jamaica bay may be saved for the purposes of pleasure and business for which it is so admirably designed.

6. Should effervescence, marked discoloration, decided turbidity, oily sleek, floating solid sewage materials or deposits of sludge be permitted anywhere in the harbor and, if so, where and under what circumstances?

Standards in regard to the physical condition of the harbor waters, like all other standards, must be interpreted freely in the individual case. Occasional discoloration, turbidity and sleek can scarcely be avoided in the vicinity of a great city. In general, however, I am of the opinion that effervescence, marked discoloration, decided turbidity, oily sleek, floating solid sewage materials and deposits of sludge should not be permitted anywhere in the harbor. Such conditions, if persistent or of frequent occurrence, are wholly unnecessary and constitute a short-sighted and uneconomic waste of one of the city's most precious assets.

7. Should we establish one standard of cleanness for the whole harbor or should there be different standards for different parts of the metropolitan district?

There should be different standards for different regions of the harbor. Certain areas are necessarily so polluted as to be unsuitable for bathing or the taking of shellfish. Such waters should be given over to the purposes of sewage digestion subject to the regulation of conditions so that offensive sights and smells shall be avoided. The Upper bay and the Hudson, Harlem and East rivers belong for the most part in this category, although certain regions should perhaps be removed from it. On the other hand, areas like the Lower bay, which it is practicable to keep clean enough for bathing and shellfish culture, should be protected by stricter standards primarily of a sanitary nature.

8. If a definite standard of cleanness is desirable, how should that standard be expressed? Please give us a draft of your opinion as to the proper wording.

9. Will the amount of dissolved oxygen in the waters of the harbor, expressed in a percentage of its saturation value, furnish a reliable index of the cleanness of the water, and, if so, what percentage should be adopted to secure each of the following results:

(a) That the waters of the harbor may not become offensive under any weather conditions.

(b) That the use of public baths, if judiciously located, may not be prejudicial to the health of those using them.

(c) That shellfish taken from the beds in present use may be eaten without danger to health.

If the percentage of dissolved oxygen will not furnish a satisfactory standard, what standard would you suggest, and should it be based upon chemical analysis, or should it take into account chemical, physical and bacterial conditions?

The amount of dissolved oxygen in the waters of the harbor, expressed in a percentage of its saturation value, furnishes a reliable index of the cleanness of the water only when dealing with conditions of gross pollution and only then in conjunction with observations of the appearance and physical condition of the water. It tells nothing about the comparatively slight pollution that may render bathing and the taking of shellfish prejudicial to the public health. Water containing at all times 50 per cent. of the dissolved oxygen necessary for saturation will not become offensive to the sense of smell, but water containing 100 per cent. might be altogether unsuitable for bathing.

For the more polluted portions of the harbor, not suitable for bathing or the taking of shellfish, I should recommend that—

(a) The dissolved oxygen should at no time and in no place be allowed to fall below 50 per cent. of its saturation value.

(b) No effervescence, marked discoloration, decided turbidity, oily sleek, floating solid sewage materials, deposits of sludge or other conditions offensive to sight or smell should be permitted in any portion of the harbor.

For the less polluted regions, the outer bay, for example, the standards should be primarily sanitary and should rest upon bacterial rather than chemical data. Their exact limits cannot, however, be exactly formulated without further study. Clearly water which conforms to a drinking-water standard, having less than 500 bacteria per cubic centimeter and colon bacilli absent from a majority of one-cubic-centimeter samples, would be quite suitable for the purposes mentioned. Such a standard would be too severe, however, and how far it would be safe to modify it is difficult to say. The formulation of tentative standards for drinking water took twenty years and our knowledge of the bacteriology of shellfish layings and bathing beaches is in its infancy. Your Commission could make a most valuable contribution to sanitary science by a study of the actual bacterial condition of such waters around New York, and would then be better able to determine how far it is practicable to go in this regard. The chief criterion for areas used for bathing and shellfish culture should, in any case, be based upon these factors, total number of bacteria and number of colon bacilli. The dissolved oxygen requirement and the absence of offensive sights and smells should, of course, hold for any waters considered at all for the uses specified.

I am of the opinion, however, that in all these matters any standard formulated should be in the nature of a general principle to be used as a guide by some intelligent administrative body and not as a definite rule to be automatically enforced.

Respectfully yours,

C.-E. A Winslow.

New York, September 25, 1911.

PART III

Tables and Plottings of Original Data Relating to Microscopic Examinations, Numbers of Bacteria and Dissolved Oxygen

PART III

Tables and Plottings of Original Data Relating to Microscopic Examinations, Numbers of Bacteria and Dissolved Oxygen.

CHAPTER I

EXAMINATIONS OF DREDGINGS FROM THE HARBOR BOTTOM

INTRODUCTION TO TABLE XIV

In Table XIV are contained the results of examinations of solid material taken from the harbor bottom, together with the opinion of the analyst as to the certainty of sewage material being present. Plates A, B and C, opposite page 223, give much of this information graphically.

In addition to the examination number, which is the same as the sample number, and the date of collection, there are given the location from which each sample was taken, the depth of overlying water and the character of the sample with respect to color, odor and consistency. In those cases where samples were taken beneath the surface of the bottom, this fact is noted in the table. The depth which was penetrated is also stated. The numbers of bacteria per gram of wet mud are given for those samples for which bacterial counts were made.

Collection of Dredgings

The samples were collected from the Commission's floating laboratory in accordance with a plan by which it was intended to cover practically the whole area of the harbor bottom in a systematic manner. The material from the surface of the bottom was collected by means of a small iron dredge which was shaped like a mushroom anchor. The dredge consisted of an iron rod 2 feet 3 inches long, set firmly in the apex of a plate iron cone which was 6 inches deep and 12 inches across the open base. This dredge was dragged over the surface of the bottom until the cone was filled. The dredge was then raised and a pint of the contents was spooned out into a glass fruit jar. Notes were made of the color, odor and consistency of the dredged material at the time of collection. Frequently, a thin, light-brown surface was observed to overlie a black mass beneath. This showed, as experience taught, that the surface of the material had been supplied with oxygen from the water above, while the interior was in a putrefying condition.

Samples of material from beneath the surface of the harbor bottom were obtained by means of a pipe borer. This borer was made of an iron half-pipe, 2 inches in internal diameter and 11 feet long. There was a reducer at the upper end into which lengths of 1-inch iron pipe could be screwed to serve as a handle. Borings were obtained by pressing down the borer until the half-pipe was thrust to the desired depth in the bottom. The pipe was then turned round and raised aboard the vessel from which it was being operated. The samples for analysis were spooned out of the half-pipe. The outer layer of material along the entire length of the cylinder was first scraped off and discarded to avoid contamination of the sample by the solid deposits and water through which the sample was withdrawn.

Analysis of Samples

The examination of the samples in the laboratory consisted of three steps. First, the microscopic particles of débris were washed free from the rest of the sample. Second, the débris were placed in a large Petri dish over a white porcelain slab. Third, the particles which seemed likely to prove of interest were picked out of the Petri dish and identified under the microscope. In polluted samples the débris were generally so blackened that it was necessary to decolorize the particles in 10 per cent. hydrochloric acid. Mounts for microscopic examination were made in glycerine.

To wash the débris free from useless material, the analyst filled a glass jar containing the sample with water, stirred the mixture with a glass rod and poured the suspended matter upon a perforated porcelain plate which fitted snugly into an agateware funnel. The particles of solid matter which were so finely divided as to be useless for purposes of examination were washed through the perforations and the valuable débris were recovered. The process was continued until there was enough useful solid matter obtained to proceed with the examination. Ten to fifteen samples were washed in the way just described before an examination was made.

Another method of separating the débris for examination was to wash the samples upon a copper sieve with meshes 1/20 of an inch apart. When the débris of size suitable for examination had been recovered in this way, the sieve was inverted and the débris washed with a jet of water into a suitable receptacle. By agitating the contents of the receptacle and pouring them out quickly upon a porcelain plate, the materials desired for purposes of identification were obtained free from useless refuse. A sample could be made ready for examination in this way in less than eight minutes. One operator could examine 23 samples a day.

Evidence of Pollution

If the sample was from a polluted place, the débris contained bits of paper, glumes, straw, small roots, animal hairs, coal, pieces of twine, tufts of wool or cotton. These objects were fished out and transferred to a watch crystal containing 10 per cent. hydrochloric acid. When the objects became clear, they were mounted upon a glass slide for positive identification with the microscope. Glycerine diluted with 50 per cent. alcohol was used for a mounting fluid. Clinging to the microscopic objects just mentioned were other substances sometimes of much significance, such as muscle fibres, bits of starch parenchyma, fragments of seed coats, animal tissues, etc.

The identification of the débris required less and less use of the microscope, as the appearance of the particles of diagnostic value became familiar to the operator. In every doubtful case the diagnosis of pollution was supplemented by microscopic examination. The microscope used was a Spencer with a 1¼-inch eye-piece and three objectives, 1/6, 1/3 and 2/3-inch focal length, giving magnifying powers of 530, 250 and 118 diameters respectively. A dozen permanent mounts of débris from various parts of the harbor were kept on hand for study and comparison. Study was also made of a collection of vegetable and animal fibres, débris from feces and manure and city sewage.

The objects found in the samples under examination, together with the data which were collected when the samples were gathered and observations made during the washing process, formed the basis for a conclusion as to the pollution of the sample. If the sample looked clean when collected, and did not become foul before examination, and no débris were found as a result of straining, the sample was reported to be unpolluted. Whether pollution could be detected by other methods than here given was not considered in drawing a conclusion.

The most persistent evidences of pollution were bits of paper and glumes. These came to be regarded as good evidence of pollution. They were almost invariably present in polluted samples and absent from samples which, from other evidence, were known to be unpolluted. In the samples taken from the vicinity of sewer outfalls or where sewage débris collected in quantity, the presence of small seeds came to be expected. Root fragments were found in most samples. Starch parenchyma, which came, as a rule, from plant organs, such as fleshy roots, stems, seeds, fruits, etc., was taken to indicate garbage or undigested plant substances probably used as food. In some samples, what were termed natural débris were abundant. These were the remains of various plant organisms, such as fragments of roots, stems, leaves and bark which came from vegetation growing perhaps near where the samples were collected.

The location of the samples as given in the table was determined by plotting the location of the boat from which the samples were taken upon a standard United States Coast and Geodetic Survey chart, scale 1/40,000, by the aid of angles read with a sextant or prismatic compass in the hands of the sample collector. The latitudes and longitudes given in the table have been taken from these plottings.

The preliminary studies which led to the adoption of the method of microscopic examination employed in analyzing the deposits have been described in the report of the Metropolitan Sewerage Commission, dated April 30, 1910, page 415, *et seq.*, and need not be repeated here.

Bacteria in Dredgings

In some cases the number of bacteria in the deposits was determined and when this was done the result is stated in the table. The results are given as numbers of bacteria per gram of deposited material, the numbers being referable to the natural condition in which the deposited material was found, that is, without extracting, or allowing for, the water. The numbers of bacteria found in the deposits were generally large in deposits contaminated with sewage material and small where sewage material was absent.

The numbers of bacteria were determined much as in water analyses. The sample was diluted with water and a measured portion of the liquid shaken with culture medium. The culture medium employed was 10 per cent. gelatin beef extract titrated so as to have a reaction of 1.0 phenolphthalein. Incubation was continued for 48 hours at 70 degrees Fahrenheit, when the colonies were counted. The results are stated in numbers of bacteria per gram of the sample.

Analysts

The samples were collected chiefly by those who made the microscopic analyses. Raymond H. Pond, Ph.D., did this work, under the immediate direction of the President of the Commission, from August 17, 1908, to July 31, 1909. R. N. Hoyt, B. S., carried it on from the end of Dr Pond's connection to the conclusion. The bacteriological determinations were made by Payn B. Parsons, A.M., M.D.

In the preliminary studies, during which the Commission was seeking a method for the identification of soaps, fats and animal and plant débris in order to gain what was intended to be a reasonably full knowledge of the sewage, James H. Stebbins, Ph.D., was employed as consulting microscopist.

TABLE XIV

RESULTS OF THE EXAMINATION OF DREDGINGS FROM THE HARBOR BOTTOM IN THE YEARS 1908 AND 1909

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10	Long Island Sound	April 13, 1909	186
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12	Long Island Sound	April 13 and 15, 1909	187
13	Upper bay	April 21 to 29, 1909	187
14	Hudson river	May 3, 1909	189
15	The Narrows	May 5 to 7, 1909	189
16	Upper bay	May 7, 1909	190
17	Newark bay and Passaic river	May 8, 1909	190
18	Hudson river	May 14 and 15, 1909	191
19	Lower bay	May 17 to 19, 1909	192
20	East river	May 29 to June 7, 1909	194
21	Long Island Sound	June 8, 1909	195
22	Lower bay	June 12, 1909	196
23	Eastchester bay	June 14, 1909	196
24	Little Neck bay	June 23, 1909	197
25	East river	June 23, 1909	197
26	Jamaica bay	June 29 to July 1, 1909	197
27	Hudson river	July 7, 1909	198
28	Gravesend bay	July 9, 1909	199
29	Upper bay	July 15 to 21, 1909	199
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31	Atlantic Ocean	July 21, 1909	201
32	Hudson river	Aug 19 and Sept. 7, 1909	202
33	Passaic river and Newark bay	Sept. 8, 1909	202
34	Kill van Kull	Sept. 8 and 11, 1909	203
35	Lower bay	Sept. 13 and 14, 1909	203
36	Arthur Kill	Sept. 16, 1909	204
37	Lower bay	Sept. 20, 1909	204
38	Raritan bay	Sept. 21, 1909	205
39	Arthur Kill	Sept. 21, 1909	205
40	Hudson river	Oct. 1, 1909	205
41	Harlem river	Oct. 11, 1909	206
42	East river	Oct. 1, 1909	206
43	Hudson river	Oct. 2, 1909	206
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50	Upper bay	Oct. 11, 1909	210
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54	Kill van Kull	Oct. 16, 1909	213
55	Upper bay	Oct. 18, 1909	214
56	Hudson river	Oct. 18, 1909	214
57	Newark bay	Oct. 21, 1909	215
58	Hudson river	Oct. 22, 1909	217
59	Upper bay	Oct. 23, 1909	217
60	Hudson river	Oct. 25, 1909	218
61	Newark bay	Nov. 3, 1909	218
62	Hudson river	Nov. 4 and 6, 1909	220

TABLE XIV

Results of the **Examination of Dredgings** from the Harbor Bottom, in the Years 1908 and 1909

1—EAST RIVER

No. *	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
20	Nov. 16, 1908	25 feet off pier at E. 6th Street...	40 43 15	73 58 25	40	Black	H_2S	Sludge	Polluted
21	Nov. 16, 1908	In slip between Piers 17–18......	40 42 21	74 00 08	30	Black	H_2S	Sludge	Polluted
22	Nov. 16, 1908	In slip between Piers 15–16......	40 42 19	74 00 12	30	Black	H_2S	Sludge	Polluted
23	Nov. 16, 1908	In slip between Piers 48–49......	40 42 54	73 58 33	30	Black	H_2S	Sludge	Polluted
24	Nov. 16, 1908	In slip between Piers 18–19......	40 42 23	74 00 07	30	Black	H_2S	Sludge	Polluted
25	Nov. 16, 1908	100 feet from abutment Williamsburg Bridge, Manhattan side...	40 42 51	73 58 29	40	Black	H_2S	Sludge	Polluted
26	Nov. 16, 1908	In slip between Piers 11–12......	40 42 13	74 00 22	35	Black	H_2S	Sludge	Polluted
27	Nov. 16, 1908	In slip between Piers 30–31......	40 42 32	73 59 36	35	Black	H_2S	Sludge	Polluted
28	Nov. 16, 1908	In slip between Piers 14–15......	40 42 18	74 00 15	35	Black	H_2S	Sludge	Polluted
29	Nov. 16, 1908	In slip between Piers 34–35......	40 42 35	73 59 21	35	Black	H_2S	Sludge	Polluted
30	Nov. 16, 1908	100 feet off center line bulkhead between Piers 18–19...........	40 42 24	74 00 08	40	Black	Oily, H_2S	Sludge	Polluted
31	Nov. 16, 1908	25 feet off bulkhead just east of E. 12th St......................	40 43 31	73 58 21	40	Black	Oily, H_2S	Sludge	Polluted
32	Nov. 16, 1908	100 feet off pier, Bradley Contracting Co., East river, Manhattan.	40 42 59	73 58 27	35	Black	Oily	Sludge, clay	Polluted
33	Nov. 16, 1908	In slip just east of E. 13th Street.	40 43 35	73 58 23	40	Black	Oily, H_2S	Sludge	Polluted
34	Nov. 16, 1908	In slip between Piers 12–13......	40 42 15	74 00 19	40	Black	H_2S	Sludge	Polluted
35	Nov. 16, 1908	25 feet off E. 8th St. pier........	40 43 20	73 58 22	40	Black	Oily, H_2S	Sludge	Polluted
36	Nov. 16, 1908	In slip between Piers 32–33......	40 42 33	73 59 29	35	Black	Oily, H_2S	Sludge	Polluted
37	Nov. 16, 1908	In slip between Piers 27–28......	40 42 31	73 59 44	35	—	—	Sludge, clay	Polluted
38	Nov. 16, 1908	In slip between Piers 33–34......	40 42 34	73 59 25	35	Black	Oily, H_2S	Sludge	Polluted
39	Nov. 16, 1908	In slip between Piers 45–46......	40 42 47	73 58 32	35	Black	Oily, H_2S	Sludge	Polluted
40	Nov. 16, 1908	25 feet off bulkhead, E. 10th Street	40 43 27	73 58 24	40	Black	Oily, tarry	Sludge	Polluted
41	Nov. 16, 1908	In slip between Piers 28–29......	40 42 32	73 59 41	35	Black	Oily, H_2S	Sludge	Polluted
42	Nov. 16, 1908	In slip between Piers 29–30......	40 42 32	73 58 41	35	—	—	——	Polluted

2—UPPER BAY

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
43	Dec. 5, 1908	50 feet off east pier, Governor's Island.......................	40 41 30	74 00 45	40	Black	Oily	Sludge, sand	Polluted
44	Dec. 5, 1908	300 feet southeast of Ellis Island.	40 41 50	74 02 20	20	Gray, brown	None	Clay	Doubtful
48	Dec. 5, 1908	300 feet off Owl Head...........	40 38 20	74 02 19	40	Grayish brown	None	Clay	Doubtful
49	Dec. 5, 1908	About midway between Robbin's Reef and Liberty Island.......	40 40 18	74 03 22	30	Brown	None	Clay	Doubtful
50	Dec. 5, 1908	100 feet off black spar buoy, south of Black Tom channel.........	40 41 04	74 02 40	40	—	—	Clay	Unpolluted
51	Dec. 10, 1908	Midway between Battery and Governor's Island.............	40 41 53	74 01 04	40	—	—	Sludge, mud	Doubtful
52	Dec. 10, 1908	500 feet northwest of Governor's Island light..................	40 41 38	74 01 13	50	—	—	Sludge, clay	Polluted

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* Nos. 1 to 19 covered preliminary tests with the method.

TABLE XIV—Continued

2—UPPER BAY—Continued

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
53	Dec. 10, 1908	50 feet off Governor's Island	40 41 30	74 01 15	40	—	—	Sludge, clay	Doubtful
54	Dec. 10, 1908	100 feet west of Governor's Island	40 41 18	74 01 27	35	—	—	Sludge, clay	Polluted
55	Dec. 10, 1908	2500 feet west of Governor's Island	40 41 07	74 02 09	70	—	—	Sludge, clay	Doubtful
56	Dec. 10, 1908	3000 feet southwest of Governor's Island	40 40 52	74 02 08	70	—	—	Sludge, clay	Doubtful
57	Dec. 10, 1908	¾ mile off Erie Basin	40 40 30	74 01 52	25	—	—	Sludge, clay-sand	Doubtful
58	Dec. 10, 1908	100 feet southwest of Governor's Island	40 41 10	74 01 36	30	—	—	Sludge, clay-sand	Doubtful
59	Dec. 10, 1908	500 feet southwest of Governor's Island	40 40 58	74 01 35	40	—	—	Sludge, clay	Polluted
60	Dec. 10, 1908	200 feet east of bell buoy, Governor's Island	40 40 58	74 01 48	40	—	—	Sludge, clay	Doubtful
61	Nov. 28, 1908	75 feet southwest of Aquarium	40 42 11	74 01 03	30	Black	Oily	Sludge, clay	Doubtful
62	Nov. 30, 1908	50 feet outside slip between Piers 23–24, Brooklyn	40 41 32	74 00 16	40	—	—	Ooze, sand	Doubtful
63	Nov. 30, 1908	150 feet outside slip between Piers 24–26, Brooklyn	40 41 28	74 00 20	40	—	—	Ooze, sludge	Polluted

3—HUDSON RIVER

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
64	Dec. 15, 1908	Midstream opposite Pier A, Hudson river	40 42 19	74 01 34	50	—	—	Sludge, gravel	Doubtful
66	Dec. 15, 1908	1800 feet off Pier A, Hudson river	40 42 19	74 01 31	50	—	—	Ashes, gravel	Doubtful
67	Dec. 15, 1908	3000 feet off Pier A, Hudson river	40 42 20	74 01 47	50	—	—	Sludge, clay	Polluted
68	Dec. 15, 1908	Hudson river off Pier A	40 42 15	74 01 08	50	—	—	Sludge, clay	Doubtful
69	Dec. 15, 1908	300 feet off shore C. R.R. of N. J. clock on line with Pier A, N. R.	40 42 25	74 02 00	25	Black	—	Sludge, clay	Polluted

4—UPPER BAY

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
70	Dec. 15, 1908	2000 feet east of Ellis Island	40 42 03	74 01 55	40	Black	—	Sludge, clay	Doubtful
71	Dec. 15, 1908	2000 feet northeast of Ellis Island	40 42 11	74 01 58	40	—	—	Sludge, clay	Polluted
72	Dec. 15, 1908	2500 feet east of Ellis Island	40 42 00	74 01 52	40	—	—	Sludge, clay	Doubtful
73	Dec. 15, 1908	2500 feet east of Ellis Island	40 41 52	74 01 53	40	—	—	Sludge, clay	Polluted
74	Dec. 15, 1908	1000 feet southeast of Communipaw	40 42 13	74 01 54	40	—	—	Sludge, clay	Polluted
75	Dec. 15, 1908	2500 feet southeast of Ellis Island	40 41 41	74 01 52	35	—	—	Sludge, clay	Polluted
76	Dec. 15, 1908	3000 feet southeast of Ellis Island	40 41 25	74 01 52	80	—	—	Sludge, clay	Doubtful
77	Dec. 15, 1908	3500 feet southeast of Ellis Island	40 41 37	74 01 38	110	Black	—	Sludge, clay	Polluted

TABLE XIV—Continued

4—UPPER BAY—Continued

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
78	Dec. 15, 1908	500 feet west of Governor's Island	40 41 18	74 01 35	30	—	—	Sludge, clay	Polluted
79	Dec. 15, 1908	100 feet off buoy S. 2 off Liberty Island	40 41 12	74 02 37	40	—	—	Sludge, clay	Polluted
80	Dec. 15, 1908	500 feet south of red gas buoy 2, Black Tom channel	40 40 58	74 02 44	50	—	—	Sludge, clay	Doubtful
81	Dec. 15, 1908	South edge Black Tom channel	40 41 12	74 02 50	15	Brown	—	Clay	Doubtful
82	Dec. 16, 1908	500 feet off Battery	40 42 07	74 01 07	30	—	—	Sludge, gravel-clay	Polluted
83	Dec. 16, 1908	Halfway across Hudson river, opposite Pier A	40 42 19	74 01 34	50	—	—	Sludge, clay	Polluted
84	Dec. 16, 1908	⅓ way across Hudson river, opposite Pier A	40 42 18	74 01 26	50	—	—	Sludge, clay	Polluted
85	Dec. 16, 1908	3000 feet east of Ellis Island	40 41 54	74 01 37	40	Brown	—	Sludge, clay	Polluted
86	Dec. 16, 1908	2000 feet off C. R.R. of N. J. pier	40 42 17	74 01 38	40	Black	—	Sludge	Doubtful
87	Dec. 16, 1908	1000 feet off C. R.R. of N. J. pier	40 42 19	74 01 45	48	Black	—	Sludge	Doubtful
88	Dec. 16, 1908	500 feet off Battery	40 42 07	74 01 11	30	—	—	Sludge	Polluted
89	Dec. 16, 1908	150 feet off Battery	40 42 09	74 01 05	30	—	—	Sludge	Polluted
90	Dec. 16, 1908	2100 feet off C. R.R. of N. J. pier	40 42 12	74 01 38	50	—	—	Sludge	Polluted
91	Dec. 16, 1908	1500 feet off C. R.R. of N. J. pier	40 42 13	74 01 47	50	—	—	Sludge, gravel	Polluted
92	Dec. 16, 1908	600 feet east of Ellis Island	40 41 57	74 02 06	30	—	—	Sludge	Polluted
93	Dec. 16, 1908	400 feet east of Ellis Island	40 41 52	74 02 10	25	—	—	Sludge	Polluted
94	Dec. 17, 1908	600 feet east of Liberty Island	40 41 21	74 02 24	40	Black	Oily	Sludge	Polluted
95	Dec. 17, 1908	2500 feet east of Liberty Island	40 41 25	74 02 05	40	Brown	—	Sludge, clay	Polluted
96	Dec. 17, 1908	2500 feet west of Governor's Island	40 41 25	74 01 52	70	—	—	Sludge, clay	Polluted
97	Dec. 17, 1908	600 feet east of Liberty Island	40 41 24	74 02 30	40	—	—	Sludge, clay	Polluted
98	Dec. 17, 1908	½ mile southwest of Battery	40 41 55	74 01 26	40	Black	Oily	Sludge	Polluted
99	Dec. 17, 1908	½ mile southwest of Battery	40 41 59	74 01 28	40	Black	—	Sludge	Polluted
100	Dec. 21, 1908	500 feet northwest of Governor's Island	40 41 33	74 01 27	60	—	—	Sludge, clay	Polluted
101	Dec. 21, 1908	500 feet northwest of Governor's Island	40 41 38	74 01 20	60	Black, brown	Oily	Sludge, clay	Polluted
102	Dec. 21, 1908	200 feet northwest of Governor's Island	40 41 38	74 01 25	40	—	—	Sludge, clay	Polluted
103	Dec. 21, 1908	3000 feet east of Ellis Island	40 41 57	74 01 46	40	—	—	Sludge, clay	Polluted
104	Dec. 21, 1908	300 feet north of Liberty Island docks	40 41 27	74 02 35	15	—	—	Clay	Doubtful
105	Dec. 21, 1908	500 feet south of Ellis Island	40 41 49	74 02 20	10	—	—	Clay	Polluted
106	Dec. 21, 1908	On line Liberty Island to Ellis Island halfway	40 41 37	74 02 30	8	—	—	Clay	Polluted
107	Dec. 21, 1908	600 feet south of east dock of Ellis Island	40 41 50	74 02 21	15	—	—	Clay	Polluted
108	Dec. 21, 1908	300 feet east of Ellis Island	40 41 59	74 02 15	15	—	—	Clay	Polluted
109	Dec. 21, 1908	500 feet north of Ellis Island	40 42 07	74 02 16	10	—	—	Sludge, clay	Polluted
110	Dec. 21, 1908	300 yards off Ellis Island on line with Liberty and Ellis Islands	40 41 44	74 02 24	6	—	—	Clay	Unpolluted
111	Dec. 21, 1908	300 feet off dock, Communipaw	40 42 17	74 01 59	6	—	—	Sludge, clay	Polluted
112	Dec. 21, 1908	100 yards off 4th dock, south of C. R.R. of N. J. ferry	40 42 14	74 02 02	20	—	—	Sludge, clay	Polluted
113	Dec. 21, 1908	Halfway between C. R.R. of N. J. ferry and Pier A	40 42 19	74 01 34	50	—	—	Sludge, clay	Doubtful
114	Dec. 22, 1908	500 feet southeast of Liberty Island	40 41 17	74 02 33	40	—	Oily	Clay	Polluted
115	Dec. 22, 1908	2500 feet southeast of Ellis Island	40 41 45	74 01 52	40	—	Oily	Sludge, clay	Polluted
116	Dec. 22, 1908	2000 feet southeast of Ellis Island	40 41 38	74 02 03	40	—	—	Clay	Polluted
117	Dec. 22, 1908	2800 feet southeast of Ellis Island	40 41 44	74 01 47	40	—	Oily	Sludge, clay	Polluted
118	Dec. 22, 1908	1000 feet southeast of Liberty Island	40 41 08	74 02 26	40	—	—	Sludge, clay	Polluted

TABLE XIV—Continued

4—UPPER BAY—Continued

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude ° ′ ″	Longitude ° ′ ″					
119	Dec. 22, 1908	500 feet east of C. R.R. of N. J. ferry	40 42 25	74 01 57	40	Black	—	Sludge	Polluted
120	Dec. 22, 1908	500 feet southeast of C. R.R. of N. J. ferry	40 42 22	74 01 59	40	—	—	Sludge, clay	Polluted
121	Dec. 22, 1908	2000 feet northeast of Liberty Island	40 41 37	74 02 21	40	Black	—	Sludge, clay	Polluted
122	Dec. 24, 1908	200 feet north of Black Tom pier	40 41 48	74 03 20	8	Brown	—	Clay	Doubtful
123	Dec. 24, 1908	100 yards northeast of Black Tom	40 41 43	74 03 08	8	Brown	—	Sludge, clay	Doubtful
124	Dec. 24, 1908	Midway between Black Tom water tower and Liberty Island	40 41 22	74 03 06	8	Black	—	Sludge	Unpolluted
125	Dec. 24, 1908	300 feet north of Liberty Island	40 41 30	74 02 04	8	Black	—	Sludge	Doubtful
126	Dec. 24, 1908	600 feet north of Liberty Island	40 41 34	74 02 43	6	—	—	——	Polluted
127	Dec. 24, 1908	West end Liberty Island to west end Ellis Island, midway	40 41 40	74 02 41	6	Black	—	Sludge	Polluted
128	Dec. 24, 1908	200 yards from southwest corner of Ellis Island	40 41 53	74 02 47	6	—	—	Sludge, clay	Doubtful
129	Dec. 24, 1908	100 yards off southwest corner of Ellis Island	40 41 57	74 02 42	6	—	—	Sludge, clay	Doubtful
130	Dec. 24, 1908	200 feet off southwest corner of Ellis Island, on line Black Tom water tower	40 41 53	74 02 40	6	—	—	Sludge, clay	Polluted
131	Dec. 24, 1908	200 yards from Ellis Island, on line Black Tom water tower	40 41 52	74 02 45	8	Black	—	Sludge	Polluted
132	Dec. 24, 1908	On line southwest corner Ellis Island and Black Tom water tower, halfway	40 41 43	74 02 54	8	—	—	Sludge, clay	Polluted
133	Dec. 24, 1908	On line southwest corner Ellis Island and Black Tom water tower, about halfway	40 41 38	74 02 53	8	—	—	Sludge, clay	Doubtful
134	Dec. 24, 1908	On line southwest corner of Ellis Island and Black Tom water tower, 200 yards off Black Tom shore	40 41 39	74 03 18	8	—	—	Sludge, clay	Unpolluted
135	Dec. 24, 1908	On line southwest corner of Ellis Island and Black Tom water tower, 100 yards off Black Tom shore	40 41 38	74 03 23	8	—	—	Sludge, clay	Polluted
136	Dec. 24, 1908	On line southeast corner of Ellis Island and northwest corner Liberty, 100 yards off Ellis Island	40 41 44	74 02 35	8	—	—	Sludge, clay	Polluted
137	Dec. 24, 1908	On line southeast corner of Ellis Island and northwest corner Liberty, midway	40 41 37	74 02 39	8	—	—	Sludge, clay	Polluted
138	Dec. 24, 1908	100 yards off northwest corner Ellis Island	40 42 04	74 02 29	6	—	—	Sludge, clay	Polluted
139	Dec. 24, 1908	Near gas buoy 2, Black Tom channel	40 41 07	74 02 37	15	—	Oily	Clay	Polluted
140	Dec. 24, 1908	Midway between buoys 2 and 4, Black Tom channel	40 41 12	74 02 46	15	—	Oily	Clay	Polluted
141	Dec. 24, 1908	Between buoys 4 and 6, Black Tom channel	40 41 18	74 02 52	15	—	—	Sludge, clay	Polluted
142	Dec. 24, 1908	Near Liberty Island	40 41 25	74 02 48	8	—	—	Sludge, clay	Polluted
143	Dec. 24, 1908	Midway between Ellis Island and Liberty Island	40 41 42	74 02 48	8	—	—	Sludge, clay	Doubtful
144	Dec. 24, 1908	1000 feet north of Liberty Island	40 41 37	74 02 45	6	—	—	Sludge, clay	Unpolluted
145	Dec. 24, 1908	100 feet off southwest corner of Ellis Island	40 41 57	74 02 36	12	—	—	Clay	Unpolluted
146	Dec. 24, 1908	100 feet off center line of the west bulkhead, Ellis Island	40 42 00	74 02 32	8	—	—	Clay	Doubtful
147	Feb. 12, 1909	1000 feet west of Erie Basin	40 40 24	74 01 20	35	Black	Oily, tarry	Sludge, clay	Polluted

TABLE XIV—Continued

4—UPPER BAY—Continued

No.	Date of Collection	Location of Samples: Approximate	Location of Samples: Latitude ° ′ ″	Location of Samples: Longitude ° ′ ″	Depth of Water (feet)	Color	Odor	Consistency	Opinion
148	Feb. 12, 1909	1500 feet west of Erie Basin	40 40 29	74 01 25	15	Black	Oily, tarry	Sludge, sand	Polluted
149	Feb. 12, 1909	2000 feet west of Erie basin	40 40 34	74 01 32	15	—	—	Sand	Unpolluted
150	Feb. 12, 1909	2800 feet west of Erie basin	40 40 37	74 01 37	20	—	—	Sand	Polluted
151	Feb. 12, 1909	3500 feet west of Erie basin	40 40 40	74 01 42	20	Black	Tarry, oily	Sludge, clay	Polluted
152	Feb. 12, 1909	4000 feet west of Erie basin	40 40 42	74 01 49	20	Black	Tarry, oily	Sludge, clay	Polluted
153	Feb. 12, 1909	4500 feet west of Erie basin	40 40 47	74 01 54	20	Black	Oily	Sludge, clay	Polluted
154	Feb. 12, 1909	5000 feet west of Erie basin	40 40 50	74 02 00	20	Black	—	Sand, sludge clay	Polluted
155	Feb. 12, 1909	6000 feet west of Erie basin	40 40 57	74 02 10	30	Black	—	Sludge, clay	Polluted
156	Feb. 12, 1909	5000 feet east of Black Tom	40 41 01	74 02 19	30	Black	—	Sludge, clay	Polluted
157	Feb. 12, 1909	4000 feet east of Black Tom	40 41 06	74 02 30	10	Black	—	Sludge, clay	Polluted
158	Feb. 12, 1909	500 feet south of Liberty Island	40 41 18	74 02 38	10	Black	—	Sludgy clay	Polluted
159	Feb. 12, 1909	500 feet south of Caven Point	40 41 35	74 04 28	6	Black	—	Sludge, clay	Unpolluted
160	Feb. 12, 1909	1000 feet south of Caven Point	40 41 28	74 04 26	6	Black	—	Sludge, clay	Unpolluted
161	Feb. 12, 1909	1000 feet southeast of Caven Point	40 41 26	74 04 21	10	Black	—	Sludge, clay	Unpolluted
162	Feb. 12, 1909	1500 feet southeast of Caven Point	40 41 22	74 04 22	10	Black	—	Sludge, clay	Doubtful
163	Feb. 12, 1909	1800 feet southeast of Caven Point	40 41 19	74 04 11	10	Black	—	Sludge, clay	Doubtful
164	Feb. 12, 1909	2000 feet southeast of Caven Point	40 41 18	74 03 56	10	Black	—	Sludge, clay	Unpolluted
165	Feb. 12, 1909	3500 feet southeast of Caven Point	40 41 07	74 03 41	10	Black	—	Sludge, clay	Unpolluted
166	Feb. 12, 1909	4500 feet southeast of Caven Point	40 41 07	74 03 27	10	—	—	Sand, clay	Unpolluted
167	Feb. 18, 1909	2000 feet east of buoy N 14, off Gowanus bay	40 40 05	74 01 43	20	Black	Oily, tarry	Sludge, clay	Polluted
168	Feb. 18, 1909	1000 feet east of buoy N 14, off Gowanus bay	40 40 08	74 01 53	20	Black	Oily, tarry	Sludge, sand	Polluted
169	Feb. 18, 1909	1000 feet north of buoy N 14, off Gowanus bay	40 40 19	74 02 08	25	—	Oily	Sludge, sand	Polluted
170	Feb. 18, 1909	2000 feet northeast of buoy N 14, off Gowanus bay	40 40 25	74 02 18	25	Black	Oily, tarry	Sludge, clay	Polluted
171	Feb. 18, 1909	3500 feet northeast of buoy N 14, off Gowanus bay	40 40 35	74 02 27	30	Black	—	Sludge, sand	Polluted
172	Feb. 18, 1909	4000 feet northeast of buoy N 14, off Gowanus bay	40 40 40	74 02 33	30	Brown	Oily	Sludge, clay	Polluted
173	Feb. 18, 1909	4500 feet northeast of buoy N 14, off Gowanus bay	40 40 43	74 02 37	30	Black	Oily, tarry	Sludge, sand	Polluted
174	Feb. 18, 1909	5000 feet northeast of buoy N 14, off Gowanus bay	40 40 50	74 02 35	30	Black	Oily, tarry	Sludge, sand	Polluted
175	Feb. 18, 1909	5000 feet northeast of buoy N 14, off Gowanus bay	40 40 47	74 02 39	30	Black	—	Sludge, sand	Polluted
176	Feb. 18, 1909	2500 feet north of buoy G 2	40 40 28	74 02 54	40	Black	—	Clay, gravel	Polluted
177	Feb. 18, 1909	2000 feet north of buoy G 2	40 40 25	74 02 50	35	—	Oily	Sludge, sand	Polluted
178	Feb. 18, 1909	1800 feet north of buoy G 2	40 40 25	74 03 00	35	—	—	Sludge, clay	Polluted
179	Feb. 18, 1909	2500 feet north of buoy G 2	40 40 31	74 03 05	40	—	Oily	Sand, sludge, clay	Polluted
180	Feb. 18, 1909	3500 feet north of buoy G 2	40 40 39	74 03 10	40	Black	—	Sludge, clay	Polluted
181	Feb. 18, 1909	3000 feet north of buoy G 2	40 40 37	74 03 14	40	—	Tarry, oily	Sludge, clay	Polluted
182	Feb. 18, 1909	5000 feet northeast of buoy G 2	40 40 55	74 03 23	30	—	—	Sludge, clay	Doubtful
183	Feb. 18, 1909	1 mile northeast of buoy G 2	40 40 58	74 03 33	30	Black	—	Sludge, clay	Polluted
184	Feb. 19, 1909	Near buoy N 14, at mouth of Gowanus bay	40 40 04	74 02 08	30	—	—	Sludge, sand	Polluted

TABLE XIV—Continued

4—UPPER BAY—Continued

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
185	Feb. 19, 1909	800 feet northeast of buoy N 14...	40 40 07	74 02 03	30	Black	Oily	Sludge, sand	Polluted
186	Feb. 19, 1909	1000 feet east of buoy N 14.......	40 40 04	74 01 57	30	Black	Oily	Sludge	Polluted
187	Feb. 19, 1909	1600 feet east of buoy N 14.......	40 40 00	74 01 50	30	Black	Oily	Sludge	Polluted
188	Feb. 19, 1909	2500 feet east of buoy N 14.......	40 40 00	74 01 40	30	Black	Oily, tarry	Sludge	Polluted
189	Feb. 19, 1909	2200 feet off southern end of Erie basin....	40 39 57	74 01 34	30	—	Oily, tarry	Sludge, clay	Polluted
190	Feb. 19, 1909	1900 feet off southern end of Erie basin.......................	40 39 54	74 01 30	30	—	Oily, tarry	Sludge, clay	Polluted
191	Feb. 19, 1909	1500 feet off southern end of Erie basin:......................	40 39 53	74 01 25	30	—	Oily, tarry	Sludge, clay	Polluted
192	Feb. 19, 1909	1200 feet off southern end of Erie basin.......................	40 39 53	74 01 21	30	—	Oily, tarry	Sludge, clay	Polluted
193	Feb. 19, 1909	900 feet off southern end of Erie Basin.......................	40 39 52	74 01 16	30	Black	Oily, tarry	Sludge, clay	Polluted
194	Feb. 23, 1909	2000 feet off 39th street, Brooklyn.	40 39 40	74 01 13	20	Black	Oily	Sludge	Polluted
195	Feb. 23, 1909	2500 feet off 39th street, Brooklyn.	40 39 38	74 01 26	20	Black	Oily	Sludge	Polluted
196	Feb. 23, 1909	2600 feet off 39th street, Brooklyn.	40 39 42	74 01 21	25	Black	Oily	Sludge, sand, clay	Polluted
197	Feb. 23, 1909	1000 feet east of buoy N 14, off Gowanus bay.................	40 40 00	74 01 50	25	Black	—	Sludge, clay	Polluted
198	Feb. 23, 1909	1000 feet southeast of buoy N 14, off Gowanus Bay................	40 39 57	74 01 54	20	Black	—	Sludge, clay	Polluted
199	Feb. 23, 1909	Near buoy N 14, off Gowanus bay.	40 40 01	74 02 12	25	Black	—	Sludge, clay	Polluted
200	Feb. 23, 1909	500 feet west of buoy N 14, off Gowanus bay.................	40 40 08	74 02 15	30	Black	—	Sludge, clay	Polluted
201	Feb. 23, 1909	1000 feet west of buoy N 14, off Gowanus bay.................	40 40 08	74 02 30	30	—	—	Sand	Polluted
202	Feb. 23, 1909	1000 feet northwest of buoy N 14, off Gowanus bay..............	40 40 14	74 02 29	30	Black	—	Sludge, clay	Polluted
203	Feb. 23, 1909	2000 feet northwest of buoy N 14, off Gowanus bay..............	40 40 21	74 02 27	30	Black	—	Sludge, clay	Polluted
204	Feb. 23, 1909	3000 feet northwest of buoy N 14, off Gowanus bay..............	40 40 19	74 02 50	40	Black	—	Sludge, clay	Polluted
205	Feb. 26, 1909	1000 feet north of buoy G 2.......	40 40 20	74 03 08	40	Brown	—	Sand, clay	Polluted
206	Feb. 26, 1909	2500 feet northwest of buoy G 2...	40 40 29	74 03 13	10	—	—	——	Polluted
207	Feb. 26, 1909	3000 feet northwest of buoy G 2...	40 40 33	74 03 16	10	—	—	Clay	Polluted
208	Feb. 26, 1909	4000 feet northwest of buoy G 2...	40 40 37	74 03 23	10	Black	—	Clay	Doubtful
209	Feb. 26, 1909	5000 feet northwest of buoy G 2...	40 40 44	74 03 28	10	Black	—	Clay	Unpolluted
210	Feb. 26, 1909	1 mile northwest of buoy G 2......	40 40 52	74 03 28	10	Black	—	Clay	Polluted
211	Feb. 26, 1909	3500 feet northeast of P. R.R. terminal, Greenville..............	40 40 57	74 03 39	8	Black	—	Clay	Doubtful
212	Feb. 26, 1909	3000 feet northeast of P. R.R. terminal, Greenville..............	40 40 57	74 03 44	8	Black	—	Clay	Doubtful
213	Feb. 26, 1909	3500 feet north of P. R.R. terminal, Greenville....................	40 41 03	74 03 52	8	Black	—	Clay	Unpolluted
214	Feb. 26, 1909	3000 feet southeast of Caven Point.	40 41 04	74 04 00	8	Brown	—	Subsoil	Doubtful
215	Feb. 26, 1909	2000 feet southeast of Caven Point.	40 41 11	74 04 04	8	Brown	—	Subsoil	Unpolluted
216	Feb. 26, 1909	2000 feet south of Caven Point....	40 41 12	74 04 15	4	Brown	—	Subsoil	Unpolluted
217	Feb. 26, 1909	3000 feet south of Caven Point....	40 41 03	74 04 18	4	—	—	Clay	Unpolluted
218	Feb. 26, 1909	3500 feet south of Caven Point....	40 40 57	74 04 13	4	—	—	Clay	Doubtful
219	Feb. 26, 1909	2500 feet northeast of P. R.R. terminal, Greenville..............	40 40 54	74 04 01	8	—	—	Clay	Unpolluted

TABLE XIV—Continued

4—UPPER BAY—Continued

No.	Date of Collection	Location of Samples: Approximate	Latitude	Longitude	Depth of Water (feet)	Color	Odor	Consistency	Opinion
			° ′ ″	° ′ ″					
220	Feb. 26, 1909	2000 feet northeast of P. R.R. terminal, Greenville	40 40 50	74 03 57	8	—	—	Clay	Unpolluted
221	Feb. 26, 1909	3000 feet northeast of P. R.R. terminal, Greenville	40 40 47	74 03 50	8	—	—	Clay	Unpolluted
222	Feb. 26, 1909	3000 feet east of P. R.R. terminal, Greenville	40 40 42	74 03 42	12	Black	—	Subsoil	Doubtful
223	Feb. 26, 1909	2500 feet east of P. R.R. terminal, Greenville	40 40 39	74 03 36	12	Black	—	Clay	Doubtful
224	Feb. 26, 1909	3800 feet east of P. R.R. terminal, Greenville	40 40 31	74 03 28	12	Black	—	Clay	Polluted
225	Feb. 26, 1909	4000 feet east of P. R.R. terminal, Greenville	40 40 23	74 03 23	15	Black	—	Clay	Polluted
226	Feb. 26, 1909	1500 feet northwest of buoy G 2	40 40 19	74 03 14	12	Black	Oily	Sludge, subsoil	Polluted
227	Feb. 26, 1909	1000 feet northwest of buoy G 2	40 40 10	74 03 06	12	—	Oily	Sludge, sand, gravel	Polluted
228	Feb. 26, 1909	500 feet northeast of buoy G 2	40 40 05	74 02 55	20	—	Oily	Sludge, sand, gravel	Doubtful
229	Feb. 26, 1909	1000 feet south of buoy G 2	40 39 52	74 02 52	40	Black	Oily	Sludge, clay	Doubtful
230	Feb. 26, 1909	1500 feet southeast of buoy G 2	40 39 50	74 02 43	50	—	—	Sludge, sand	Doubtful
231	Feb. 27, 1909	¾ mile southwest of buoy N 14, off Gowanus bay	40 39 36	74 02 52	30	—	Oily	Sludge, sand, clay	Unpolluted
232	Feb. 27, 1909	½ mile southwest of buoy N 14	40 39 49	74 02 38	30	—	Oily	Sludge, sand	Polluted
233	Feb. 27, 1909	½ mile southwest of buoy N 14	40 39 45	74 02 32	30	—	Oily	Sludgy, sand	Polluted
234	Feb. 27, 1909	2400 feet south of buoy N 14	40 39 40	74 02 24	30	—	—	Sand	Polluted
235	Feb. 27, 1909	2300 feet south of buoy N 14	40 39 38	74 02 08	30	Black	Oily	Clay, sand	Polluted
236	Feb. 27, 1909	3000 feet southeast of buoy	40 39 34	74 01 58	20	Black	Oily	Clay	Polluted
237	Feb. 27, 1909	3500 feet southeast of buoy N 14	40 39 33	74 01 51	20	Black	Oily	Clay	Polluted
238	Feb. 27, 1909	2800 feet off shore opposite 40th street, Brooklyn	40 39 27	74 01 40	20	—	Oily	Sand	Polluted
239	Feb. 27, 1909	2100 feet off shore opposite 39th street, Brooklyn	40 39 27	74 01 28	20	Black	—	Sludge, clay	Polluted
240	Feb. 27, 1909	About 1 mile northeast of Robbins Reef light	40 39 40	74 02 51	40	Black	Oily	Clay	Polluted
241	Feb. 27, 1909	About 1 mile northeast of Robbins Reef light	40 39 43	74 03 01	40	Black	Oily	Clay	Polluted
242	Feb. 27, 1909	About ⅞ mile northeast of Robbins Reef light	40 39 49	74 03 08	40	Black	Oily	Clay	Polluted
243	Feb. 27, 1909	About 1 mile northeast of Robbins Reef light	40 39 55	74 03 07	40	Black	Oily	Clay	Polluted
244	Feb. 27, 1909	About 1 mile north of Robbins Reef light	40 40 03	74 03 13	40	Black	—	Sludge, subsoil	Polluted
245	Feb. 27, 1909	About 1 mile north of Robbins Reef light	40 40 07	74 03 22	40	Black	—	Sludge	Polluted
246	Feb. 27, 1909	About 1 mile north of Robbins Reef light	40 40 08	74 03 34	40	Black	—	Sludge	Polluted
247	Feb. 27, 1909	About 1 mile north of Robbins Reef light	40 40 18	74 03 42	40	Brown	—	Subsoil	Doubtful
248	Feb. 27, 1909	About 1 mile north of Robbins Reef light	40 40 20	74 03 54	40	Brown	—	Subsoil	Polluted
249	Mar. 3, 1909	1500 feet off shore 65th street, Brooklyn	40 38 49	74 02 13	30	Brown	—	Subsoil	Polluted
250	Mar. 3, 1909	1700 feet off shore 65th street, Brooklyn	40 38 53	74 02 08	30	Brown	—	Subsoil	Polluted
251	Mar. 3, 1909	2500 feet off shore 65th street, Brooklyn	40 38 57	74 02 20	30	—	—	Sand	Polluted

TABLE XIV—Continued

4—UPPER BAY—Continued

No.	Date of Collection	Location of Samples: Approximate	Latitude	Longitude	Depth of Water (feet)	Color	Odor	Consistency	Opinion
			° ′ ″	° ′ ″					
252	Mar. 3, 1909	3600 feet off shore 65th street, Brooklyn	40 39 02	74 02 35	30	—	Oily	Sand	Polluted
253	Mar. 3, 1909	3300 feet off shore 65th street, Brooklyn	40 38 55	74 02 36	30	—	Oily	Sand	Polluted
254	Mar. 3, 1909	4200 feet off shore 65th street, Brooklyn	40 39 02	74 02 43	30	—	Oily	Sand	Doubtful
255	Mar. 3, 1909	1 mile off shore 65th street, Brooklyn	40 39 04	74 02 51	30	—	Oily	Sludge, sand	Polluted
256	Mar. 3, 1909	1 mile off shore 65th street, Brooklyn	40 38 58	74 02 55	30	Brown	Oily	Clay, sand	Polluted
257	Mar. 3, 1909	½ mile east of Robbins Reef bell buoy	40 39 11	74 03 09	35	Brown	—	Clay	Doubtful
258	Mar. 6, 1909	1800 feet off shore 60th street, Brooklyn	40 39 00	74 01 52	30	Brown	Oily	Clay	Polluted
259	Mar. 6, 1909	2600 feet off shore 62nd street, Brooklyn	40 38 58	74 02 05	30	Black	—	Sludge, clay	Polluted
260	Mar. 6, 1909	3200 feet off shore 60th street, Brooklyn	40 39 03	74 02 08	30	—	—	Sand	Doubtful
261	Mar. 6, 1909	3900 feet off shore 60th street, Brooklyn	40 39 09	74 02 14	30	—	—	Sand	Unpolluted
262	Mar. 6, 1909	4400 feet off shore 60th street, Brooklyn	40 39 12	74 02 21	30	—	Oily	Sludge, sand	Polluted
263	Mar. 6, 1909	1 mile off shore 60th street, Brooklyn	40 39 17	74 02 27	30	—	Oily	Sludge, sand	Polluted
264	Mar. 6, 1909	1¼ mile off shore 60th street, Brooklyn	40 39 22	74 02 40	30	—	Oily	Sludge, sand	Polluted
265	Mar. 6, 1909	1⅛ mile off shore 60th street, Brooklyn	40 39 13	74 02 42	35	—	Oily	Sludge, sand	Polluted
266	Mar. 6, 1909	1½ mile off shore, 60th street, Brooklyn	40 39 28	74 02 54	35	Brown	—	Clay	Polluted
267	Mar. 6, 1909	1¾ mile off shore 60th street, Brooklyn	40 39 35	74 03 06	35	Black	Oily	Clay	Unpolluted
268	Mar. 6, 1909	900 feet north of Robbins Reef bell buoy	40 39 24	74 03 52	40	—	—	Gravel	Unpolluted
269	Mar. 6, 1909	1000 feet northeast of Robbins Reef bell buoy	40 39 17	74 03 40	40	—	—	Sludge, clay	Polluted
270	Mar. 6, 1909	2000 feet east of Robbins Reef bell buoy	40 39 07	74 03 27	40	Black	Oily	Sludge, clay	Polluted
271	Mar. 6, 1909	2500 feet east of Robbins Reef bell buoy	40 39 05	74 03 19	40	Black	Oily	Clay	Polluted
272	Mar. 6, 1909	1 mile off shore 65th street, Brooklyn	40 39 11	74 02 50	30	—	Oily	Sludge, sand	Polluted
273	Mar. 6, 1909	1200 feet south of Robbins Reef light	40 39 04	74 03 55	40	Black	H_2S	Subsoil	Doubtful
274	Mar. 6, 1909	¾ mile south of Robbins Reef light	40 38 50	74 04 08	35	—	Oily	Sand, gravel	Doubtful
275	Mar. 6, 1909	3000 feet southwest of Robbins Reef light	40 39 04	74 04 22	35	—	—	Gravel	Doubtful
276	Mar. 6, 1909	3000 feet south of Robbins Reef light	40 38 57	74 04 05	30	—	—	Sand	Doubtful
277	Mar. 6, 1909	⅞ mile south of Robbins Reef light	40 38 39	74 03 53	35	—	—	Sand	Doubtful

5—CHEESEQUAKE CREEK

No.	Date of Collection	Location of Samples: Approximate	Latitude	Longitude	Depth of Water (feet)	Color	Odor	Consistency	Opinion	Bacteria per gram
			° ′ ″	° ′ ″						
278	Mar. 30, 1909	Cheesequake Creek, Lawrence Harbor, N. J.	40 27 30	74 16 00	2	Gray	Marshy	Clay	Unpolluted	15,000
279	Mar. 30, 1909	Cheesequake Creek, Lawrence Harbor, N. J.	40 27 30	74 16 00	2	Gray	Marshy	Clay	Unpolluted	9,000

TABLE XIV—Continued

6—UPPER BAY

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
280	Mar. 23, 1909	3300 feet off Owl Head	40 38 27	74 02 55	40	Black	—	Clay	Polluted
281	Mar. 23, 1909	500 feet north of 71st street sewer, 600 feet off shore	40 38 23	74 02 17	40	Brown	H_2S	Subsoil	Polluted
282	Mar. 23, 1909	1500 feet from Brooklyn shore, midway between Bliss tower and 71st street sewer	40 38 21	74 02 34	40	Black	—	Clay	Polluted
283	Mar. 24, 1909	2800 feet northwest of Owl Head bell buoy	40 38 45	74 03 41	25	Black	Oily	Subsoil	Doubtful
284	Mar. 24, 1909	2600 feet southwest of Owl Head bell buoy	40 38 40	74 03 41	25	Black	Oily	Subsoil	Polluted
285	Mar. 24, 1909	2100 feet northwest of Owl Head bell buoy	40 38 39	74 03 34	25	Black	Oily	Subsoil	Polluted
286	Mar. 24, 1909	2200 feet northwest of Owl Head bell buoy	40 38 40	74 03 28	25	Black	Oily	Subsoil	Polluted
287	Mar. 24, 1909	1200 feet north of Owl Head bell buoy	40 38 35	74 03 22	30	—	—	Sludge, sand	——
289	Mar. 24, 1909	900 feet north of Owl Head bell buoy	40 38 22	74 03 17	30	—	—	Sand, gravel	Polluted
290	Mar. 24, 1909	1300 feet northwest of Owl Head bell buoy	40 38 36	74 03 41	30	—	—	Sand, gravel	Polluted
291	Mar. 24, 1909	1600 feet east of Owl Head bell buoy	40 38 24	74 02 58	30	Black	—	Subsoil, clay	Polluted
292	Mar. 24, 1909	2200 feet east of Owl Head bell buoy	40 38 21	74 02 50	40	Black	—	Silt, sand	Polluted
293	Mar. 24, 1909	2100 feet east of Owl Head bell buoy	40 38 24	74 02 51	40	Black	—	Silt, sand	Polluted
294	Mar. 24, 1909	2700 feet east of Owl Head bell buoy	40 38 24	74 02 43	40	Black	—	Silt, sand	Polluted
295	Mar. 24, 1909	2800 feet east of Owl Head bell buoy	40 38 20	74 02 41	40	—	—	Silt, sand	Polluted
296	Mar. 24, 1909	3200 feet east of Owl Head bell buoy	40 38 24	74 02 37	40	Black	Oily	Silt, sand	Polluted
297	Mar. 24, 1909	4200 feet east of Owl Head bell buoy	40 38 25	74 02 26	40	Black	—	Sand, clay	Polluted
298	Mar. 24, 1909	600 feet off Owl Head	40 38 27	74 02 19	40	Black	—	Sand, clay	Polluted
299	Mar. 24, 1909	700 feet off Owl Head	40 38 18	74 02 30	40	Black	—	Subsoil	Polluted

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion	Bacteria, per gram
		Approximate	Latitude	Longitude						
			° ′ ″	° ′ ″						
300	Mar. 27, 1909	4000 feet west of Robbin's Reef light	40 39 33	74 04 43	8	Black	—	Subsoil	Unpolluted	900,000
301	Mar. 27, 1909	5000 feet west of Robbin's Reef light	40 39 30	74 05 02	8	Black	—	Subsoil	Unpolluted	950,000
302	Mar. 27, 1909	4500 feet west of Robbin's Reef light	40 39 25	74 04 57	8	Black	Oily	Subsoil	Unpolluted	1,100,000
303	Mar. 27, 1909	4000 feet west of Robbin's Reef light	40 39 22	74 04 51	8	Black	Oily	Subsoil	Doubtful	740,000
304	Mar. 27, 1909	3600 feet west of Robbin's Reef light	40 39 21	74 04 45	8	Black	Oily	Subsoil	Polluted	850,000
305	Mar. 27, 1909	3000 feet southwest of Robbin's Reef light	40 39 18	74 04 37	20	Black	Oily	Subsoil	Polluted	640,000
306	Mar. 27, 1909	2700 feet southwest of Robbin's Reef light	40 39 17	74 04 31	20	Black	Oily	Subsoil	Unpolluted	690,000
307	Mar. 27, 1909	2200 feet southwest of Robbin's Reef light	40 39 17	74 04 24	20	Black	Oily	Subsoil	Polluted	1,000,000
308	Mar. 27, 1909	1800 feet southwest of Robbin's Reef light	40 39 18	74 04 17	20	Black	Oily	Subsoil	Unpolluted	770,000
309	Mar. 29, 1909	1200 feet southwest of Robbin's Reef light	40 39 23	74 04 15	40	—	—	Sand, silt	Unpolluted	160,000

TABLE XIV—Continued

6—UPPER BAY—Continued

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion	Bacteria, per gram
		Approximate	Latitude	Longitude						
			° ′ ″	° ′ ″						
310	Mar. 29, 1909	1000 feet southwest of Robbin's Reef light	40 39 18	74 04 08	40	—	—	Silt, sand	Doubtful	670,000
311	Mar. 29, 1909	1600 feet south of Robbin's Reef light	40 39 11	74 04 05	70	—	—	Gravel	Unpolluted	——
312	Mar. 29, 1909	2800 feet south of Robbin's Reef light	40 38 53	74 03 56	30	—	Oily	Silt, sand	Polluted	480,000
313	Mar. 29, 1909	3200 feet south of Robbin's Reef light	40 38 55	74 03 51	40	—	Oily	Clay	Polluted	720,000
314	Mar. 29, 1909	1500 feet south of Robbin's Reef light	40 38 59	74 03 48	70	Black	Oily	Subsoil	Polluted	840,000
315	Mar. 29, 1909	2200 feet southeast of Robbin's Reef bell buoy	40 38 55	74 03 39	50	Black	—	Clay	Polluted	630,000
316	Mar. 29, 1909	2800 feet southeast of Robbin's Reef bell buoy	40 38 52	74 03 28	50	Black	—	Clay	Polluted	660,000
317	Mar. 29, 1909	2500 feet north of Owl Head bell buoy	40 38 52	74 03 10	35	Black	Oily	Clay	Polluted	1,200,000
318	Mar. 29, 1909	2600 feet north of Owl Head bell buoy	40 38 52	74 03 06	35	Black	Oily	Clay	Polluted	1,600,000
319	Mar. 29, 1909	2900 feet north of Owl Head bell buoy	40 38 52	74 03 10	35	Black	Oily	Clay	Polluted	940,000
320	Mar. 29, 1909	2600 feet north of Owl Head bell buoy	40 38 47	74 03 02	35	—	—	Sand	Polluted	180,000
321	Mar. 29, 1909	2800 feet northeast of Owl Head bell buoy	40 38 44	74 02 53	30	—	Oily	Silty sand	Polluted	320,000
322	Mar. 29, 1909	3000 feet off shore at Owl Head, Brooklyn	40 38 40	74 02 43	40	—	—	Silty sand	Polluted	240,000
323	Mar. 29, 1909	2400 feet off shore at Owl Head, Brooklyn	40 38 38	74 02 36	40	—	—	Silty sand	Polluted	440,000
324	Mar. 29, 1909	1500 feet off shore at Owl Head, Brooklyn	40 38 35	34 02 27	40	Black	—	Clay	Polluted	840,000
325	Mar. 30, 1909	Line from 71st street sewer to St. George	40 38 14	74 02 17	40	—	Oily	Sand, clay	Polluted	6,400,000
326	Mar. 30, 1909	300 feet off shore; 100 feet off shore, sewer to St. George.	40 38 14	74 02 26	40	—	Oily	Sand, clay	Polluted	1,800,000
327	Mar. 30, 1909	Opposite 71st street, Brooklyn	— — —	— — —	40	Brown	—	Subsoil	Polluted	5,300,000
328	Mar. 30, 1909	About 800 feet off Bay Ridge.	40 38 09	74 02 30	40	Brown	—	Subsoil	Polluted	1,100,000
329	Mar. 30, 1909	About 900 feet off Bay Ridge.	40 38 22	74 02 25	40	Brown	—	Subsoil	Polluted	900,000
330	Mar. 30, 1909	1800 feet off Bay Ridge	40 38 17	74 02 36	40	Brown	Oily	Subsoil	Polluted	250,000
331	Mar. 30, 1909	2400 feet off Bay Ridge	40 38 18	74 02 43	40	Brown	—	Subsoil	Polluted	1,000,000
332	Mar. 30, 1909	2600 feet off Bay Ridge	40 38 17	74 02 50	40	—	—	Silt, sand	Polluted	600,000
333	Mar. 30, 1909	3000 feet off Bay Ridge	40 38 21	74 02 54	40	Black	Oily	Sand, clay	Polluted	2,400,000
334	Mar. 30, 1909	3800 feet off Bay Ridge	40 38 20	74 03 02	40	—	—	Silt, sand	Polluted	4,200,000
335	Mar. 30, 1909	At Owl Head bell buoy	40 38 21	74 03 14	25	—	—	Silt, sand	Polluted	3,200,000
336	Mar. 30, 1909	900 feet west of Owl Head bell buoy	40 38 24	74 03 26	35	Black	—	Clay	Doubtful	2,100,000
337	Mar. 30, 1909	1600 feet northwest of Owl Head bell buoy	40 38 28	74 03 32	35	Black	Oily	Clay	Polluted	450,000
338	Mar. 30, 1909	2800 feet northwest of Owl Head bell buoy	40 38 32	74 03 44	40	Black	Oily	Clay	Polluted	330,000
339	Mar. 30, 1909	3000 feet northwest of Owl Head bell buoy	40 38 34	74 03 50	40	—	Oily	Sand	Polluted	460,000

TABLE XIV—Continued

7—HUDSON RIVER

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion	Bacteria, per gram
		Approximate	Latitude	Longitude						
			° ′ ″	° ′ ″						
340	Apr. 15, 1909	Breakwater at Pier A, N. R....	40 42 15	74 01 05	20	—	—	Sediment	Polluted	—
341	Apr. 15, 1909	About 1200 feet off the southwest corner of Pier A.......	40 42 12	74 01 22	50	Black	Oily	Silt, gravel	Doubtful	—

8—HEMPSTEAD BAY

No.	Date of Collection	Location of Samples			Depth in feet		Color	Odor	Consistency	Opinion	Bacteria, per gram
		Approximate	Latitude	Longitude	Water	Mud					
			° ′ ″	° ′ ″							
342	Apr. 6, 1909.	200 feet back of house of John L. Lawrence........	40 37 00	73 42 00	4	0.0	Brown	Marshy	Clay	Unpolluted	45,000
343	Apr. 6, 1909.	Same as No. 342...........	40 37 00	73 42 00	4	0.5	Black	Marshy	Clay	Unpolluted	20,000
344	Apr. 6, 1909.	300 feet farther out........	40 37 00	73 42 00	4	0.0	Brown	Marshy	Clay	Unpolluted	38,000
345	Apr. 6, 1909.	Same as No. 344...........	40 37 00	73 42 00	4	0.5	Black	Marshy	Clay	Unpolluted	22,000
346	Apr. 6, 1909.	In middle of creek.........	40 37 00	73 42 00	4	0.0	Brown	Marshy	Clay	Polluted	42,000
347	Apr. 6, 1909.	In middle of creek.........	40 37 00	73 42 00	4	0.5	Black	Marshy	Clay	Unpolluted	18,000
348	Apr. 6, 1909.	Back of house of John L. Lawrence...............	40 37 00	73 42 00	4	0.0	Brown	Marshy	Clay	Unpolluted	28,000
349	Apr. 6, 1909.	Back of house of John L. Lawrence...............	40 37 00	73 42 00	4	0.7	Gray	Marshy	Clay	Doubtful	19,000

9—PELHAM BAY

No.	Date of Collection	Location of Samples			Depth in feet		Color	Odor	Consistency	Opinion	Bacteria, per gram
		Approximate	Latitude	Longitude	Water	Mud					
			° ′ ″	° ′ ″							
350	Apr. 5, 1909.	Shore of Pelham Bay Park, 600 feet west of bathing beach..................	40 52 12	73 48 18	3	0	Brown	—	Sand	Unpolluted	1,000
351	Apr. 5, 1909.	Same as No. 350...........	40 52 12	73 48 18	3	0.5	—	—	Sand	Unpolluted	1,000
352	Apr. 5, 1909.	Shore of Pelham Bay Park, 300 feet east of bathing beach..................	40 52 02	73 48 18	3	0	Brown	—	Clay	Unpolluted	53,000
353	Apr. 5, 1909.	Same as No. 352...........	40 52 02	73 48 18	3	0.5	Brown	—	Clay	Unpolluted	8,000
354	Apr. 5, 1909.	Extreme west end of same inlet near Bartow's Station	40 52 13	73 48 34	3	0.0	—	—	Clay	Unpolluted	80,000
355	Apr. 5, 1909.	Same as No. 354...........	40 52 13	73 48 24	3	0.5	—	—	Clay	Unpolluted	9,000

10—LONG ISLAND SOUND

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion	Bacteria, per gram
		Approximate	Latitude	Longitude						
			° ′ ″	° ′ ″						
356	Apr. 13, 1909	Greenpoint Harbor at oyster beds......................	41 06 00	72 21 05	15	Yellow	—	Sand	Unpolluted	4,000

TABLE XIV—Continued

11—UPPER BAY

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
357	Apr. 17, 1909	From 79th street sewer to Tompkinsville, 650 feet out from sewer	40 37 35	74 02 28	30	Black	Oily	Subsoil	Polluted
358	Apr. 17, 1909	300 feet off 79th street, Brooklyn..	40 37 51	74 02 33	30	Black	—	Sludge, sand	Polluted
359	Apr. 17, 1909	800 feet off 79th street, Brooklyn..	40 37 54	74 02 38	30	—	—	Silty sand	Polluted
360	Apr. 17, 1909	1400 feet off 79th street, Brooklyn.	40 37 55	74 02 45	40	—	—	Silty sand	Polluted
361	Apr. 17, 1909	2400 feet off 79th street, Brooklyn.	40 37 58	74 02 56	40	—	—	Silty sand	Polluted
362	Apr. 17, 1909	3000 feet off 79th street, Brooklyn.	40 38 01	74 03 03	40	—	—	Silty sand	Polluted
363	Apr. 17, 1909	2800 feet off 79th street, Brooklyn.	40 38 03	74 02 59	40	—	Oily	Sludge, clay sand	Polluted
364	Apr. 17, 1909	3500 feet off 79th street, Brooklyn.	40 38 02	74 03 11	40	—	—	Silt, sand	Polluted
365	Apr. 17, 1909	4000 feet off 79th street, Brooklyn.	40 38 05	74 03 17	50	—	Oily	Sand	Doubtful
366	Apr. 17, 1909	500 feet west of Owl Head bell buoy	40 38 18	74 03 22	35	—	Oily	Silty sand	Polluted
367	Apr. 17, 1909	4000 feet off Tompkinsville, S. I..	40 38 12	74 03 37	45	Brown	Oily	Subsoil	Polluted
368	Apr. 17, 1909	2400 feet off Tompkinsville, S. I...	40 38 20	74 03 55	55	—	—	Sand, gravel	Unpolluted
369	Apr. 17, 1909	100 feet off Pier 1, Staten Island...	40 38 23	74 04 12	35	—	Oily	Sand, gravel	Polluted

12—LONG ISLAND SOUND

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion	Bacteria, per gram
		Approximate	Latitude	Longitude						
			° ′ ″	° ′ ″						
370	Apr. 13, 1909	Gardener's bay, near Orient Point......................	41 09 00	72 12 30	30	Brown	—	Clay	Unpolluted	3,000
371	Apr. 13, 1909	½ mile off Roanoke Point....	41 00 30	72 42 00	35	Brown	—	Clay	Unpolluted	6,000
372	Apr. 13, 1909	½ mile off Woodville Landing.	40 59 50	72 49 45	35	Gray	—	Clay	Unpolluted	5,000
373	Apr. 13, 1909	Port Jefferson harbor, just inside breakwater............	40 57 00	73 05 00	20	Gray	—	Clay	Unpolluted	32,000
374	Apr. 15, 1909	½ mile off Eaton's Point.....	40 59 30	73 22 30	55	Gray	—	Clay	Unpolluted	16,000
375	Apr. 15, 1909	1 mile off Lloyd's Point.......	40 57 45	73 29 10	45	Gray	—	Clay	Unpolluted	12,000
376	Apr. 15, 1909	1 mile off Center Is. Point....	40 56 30	73 23 00	35	Gray	—	Sand, clay	Unpolluted	17,000
377	Apr. 15, 1909	1 mile off Matinicock Point...	40 55 20	73 38 25	55	Gray	—	Sand, clay	Unpolluted	22,000
378	Apr. 15, 1909	1 mile off Prospect Point......	40 52 45	73 44 25	50	Gray	—	Sand, clay	Unpolluted	18,000
379	Apr. 15, 1909	Eastchester bay, near City Island....................	40 50 00	73 47 30	15	Gray	—	Sand, clay	Unpolluted	80,000
380	Apr. 15, 1909	300 feet east of Throgs Neck..	40 48 20	73 47 20	25	Gray	—	Sand, clay	Unpolluted	140,000

13—UPPER BAY

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
381	Apr. 21, 1909	600 feet from Crescent Club, Brooklyn........................	40 37 39	74 02 40	40	Black	—	Sludge Subsoil	Polluted
382	Apr. 21, 1909	1200 feet from Crescent Club Brooklyn.....................	40 37 42	74 02 47	70	—	Oily	Sand	Polluted
383	Apr. 21, 1909	2100 feet from Crescent Club, Brooklyn.....................	40 37 38	74 02 56	70	—	—	Sand	Doubtful
384	Apr. 21, 1909	3200 feet from Crescent Club, Brooklyn....................	40 37 37	74 03 12	70	—	—	Sand, silt	Doubtful

TABLE XIV—Continued

13—UPPER BAY—Continued

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
385	Apr. 21, 1909	Midstream, opposite Crescent Club, Brooklyn	40 37 37	74 03 22	80	—	—	Sand	Unpolluted
386	Apr. 21, 1909	3800 feet out from Tompkinsville, S. I.	40 37 42	74 03 35	60	Black	—	Subsoil	Polluted
387	Apr. 21, 1909	2400 feet out from Tompkinsville, S. I.	40 37 40	74 03 50	60	Black	—	Sludge, clay	Polluted
388	Apr. 21, 1909	1100 feet out from Tompkinsville, S. I.	40 37 43	74 03 59	60	Black	—	Sludge, clay	Polluted
389	Apr. 21, 1909	1200 feet out from Stapleton, S. I.	40 37 50	74 04 11	60	Gray	Oily	Clay	Unpolluted
390	Apr. 21, 1909	500 feet out from Stapleton, S. I.	40 37 51	74 04 21	40	Black	—	Sludge, clay	Polluted
391	Apr. 21, 1909	400 feet off shore, nearly opposite 89th street, Brooklyn	40 37 25	74 02 38	30	—	Oily	Sludge, sand	Polluted
392	Apr. 21, 1909	1600 feet off shore, nearly opposite 89th street, Brooklyn	40 37 25	74 02 48	70	—	—	Sand	Polluted
393	Apr. 21, 1909	2500 feet out from Crescent Club, Brooklyn	40 37 29	74 02 55	70	—	—	Sand	Unpolluted
394	Apr. 21, 1909	Midstream, opposite Crescent Club, Brooklyn	40 37 35	74 03 07	80	—	—	Silt, sand	Unpolluted
395	Apr. 21, 1909	Midstream, opposite Crescent Club, Brooklyn	40 37 37	74 03 22	80	—	—	Silt, sand	Polluted
396	Apr. 24, 1909	About 2000 feet off 89th street, Brooklyn	40 37 23	74 02 54	70	—	Oily	Sludge, sand	Polluted
397	Apr. 24, 1909	About 1800 feet off 89th street, Brooklyn	40 37 27	74 02 53	70	—	—	Sand	Polluted
398	Apr. 24, 1909	About 1900 feet off 89th street, Brooklyn	40 37 29	74 02 54	70	—	—	Sand	Unpolluted
399	Apr. 24, 1909	About 2300 feet off 89th street, Brooklyn	40 37 33	74 02 57	70	—	—	Sand	Doubtful
400	Apr. 24, 1909	About 2200 feet off 89th street, Brooklyn	40 37 29	74 02 58	70	—	—	Sand	Doubtful
401	Apr. 24, 1909	About 2600 feet off 89th street, Brooklyn	40 37 30	74 03 02	70	—	—	Silty, sand	Unpolluted
402	Apr. 24, 1909	About 3000 feet off 89th street, Brooklyn	40 37 33	74 03 07	70	—	—	Silty, sand	Polluted
403	Apr. 24, 1909	About 3000 feet off 89th street, Brooklyn	40 37 28	74 03 07	70	—	—	Silty, sand	Polluted
404	Apr. 24, 1909	Midstream, opposite 89th street, Brooklyn	40 37 28	74 03 16	80	—	—	Sand, gravel	Doubtful
405	Apr. 24, 1909	About midstream, opposite 89th street, Brooklyn	40 37 25	74 03 22	80	—	—	Sand, gravel	Doubtful
406	Apr. 24, 1909	About 4800 feet opposite pier Canal street, Stapleton, S. I.	40 37 30	74 03 33	60	—	—	Sand, clay	Doubtful
407	Apr. 24, 1909	About 4000 feet opposite pier Canal street, Stapleton, S. I.	40 37 34	74 03 43	60	—	—	Clay, sand	Polluted
408	Apr. 24, 1909	About 3000 feet opposite pier Canal street, Stapleton, S. I.	40 37 34	74 03 55	60	Black	Oily	Clay	Doubtful
409	Apr. 24, 1909	400 feet off Canal street pier, Stapleton, S. I.	40 37 36	74 04 20	35	Black	—	Clay	Polluted
410	Apr. 24, 1909	400 feet off 91st street, Brooklyn	40 37 09	74 02 40	70	—	—	Sand	Polluted
411	Apr. 24, 1909	1000 feet off 91st street, Brooklyn	40 37 10	74 02 45	70	—	Oily	Sand	Polluted
412	Apr. 24, 1909	1500 feet off 91st street, Brooklyn	40 37 09	74 02 48	70	Black	Oily	Sludge, clay	Polluted
413	Apr. 24, 1909	1700 feet off 91st street, Brooklyn	40 37 10	74 02 52	70	—	—	Silty, sand	Polluted
414	Apr. 24, 1909	1900 feet off 91st street, Brooklyn	40 37 10	74 02 50	70	—	—	Silty, sand	Polluted
415	Apr. 24, 1909	Midstream, opposite 91st street, Brooklyn	40 37 07	74 03 10	80	—	—	Sand	Unpolluted
416	Apr. 29, 1909	About ½ mile off 89th street, Brooklyn	40 37 12	74 03 03	40	—	Oily	Silty, sand	Polluted
417	Apr. 29, 1909	Opposite 89th street, Brooklyn, midstream	40 37 12	74 03 19	70	—	—	Silty, sand	Unpolluted

TABLE XIV—Continued

13—UPPER BAY—Continued

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
418	Apr. 29, 1909	About 1500 feet off Staten Island shore opposite Clifton..........	40 37 12	74 03 28	70	—	—	Sand	Polluted
419	Apr. 29, 1909	About 800 feet off Staten Island shore opposite Clifton..........	40 37 12	74 03 36	70	—	—	——	Polluted
420	Apr. 29, 1909	About 1500 feet out from dock at Clifton, S. I..................	40 37 12	74 03 43	70	Black	—	Clay	Doubtful

14—HUDSON RIVER

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
421	May 3, 1909	50 feet off New Jersey shore opposite Riverdale................	40 54 25	73 55 56	15	Brown Black	—	Clay	Unpolluted
422	May 3, 1909	900 feet off New Jersey shore opposite Riverdale................	40 54 22	73 55 44	20	Brown Black	—	Clay	Unpolluted
423	May 3, 1909	¼ mile off New Jersey shore opposite Riverdale................	40 54 21	73 55 37	30	Brown Black	—	Clay	Unpolluted
424	May 3, 1909	⅜ mile off New Jersey shore opposite Riverdale................	40 54 20	73 55 31	35	Black	—	Subsoil	Unpolluted
425	May 3, 1909	Midstream, opposite Riverdale....	40 54 18	73 55 24	35	Gray	—	Subsoil	Unpolluted
426	May 3, 1909	2300 feet off shore Riverdale......	40 54 17	73 55 20	40	Black	—	Subsoil	Unpolluted
427	May 3, 1909	1800 feet off shore Riverdale......	40 54 17	73 55 15	40	—	—	Sand, gravel	Unpolluted
428	May 3, 1909	1200 feet off shore Riverdale......	40 54 15	73 55 09	45	Black	—	Clay	Doubtful
429	May 3, 1909	About 200 feet out from Riverdale dock........................	40 54 12	73 54 57	20	Black	—	Clay	Doubtful

15—THE NARROWS

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
430	May 5, 1909	About 500 feet out from dock above Ft. Lafayette.................	40 36 52	74 02 35	40	Black	—	Sludge, clay	Polluted
431	May 5, 1909	About 800 feet out from dock above Ft. Lafayette.................	40 36 52	74 02 40	40	—	—	Silty, sand	Polluted
432	May 5, 1909	About 1800 feet out from dock above Ft. Lafayette...........	40 36 45	74 02 47	60	Black	—	Sludge, clay	Polluted
433	May 5, 1909	About 1400 feet out from dock above Ft. Lafayette...........	40 36 49	74 02 46	70	—	—	Gravel, sand	Polluted
434	May 5, 1909	About 400 feet out from dock above Ft. Lafayette.................	40 36 52	74 02 39	40	Gray	—	Clay	Polluted
435	May 6, 1909	Midstream, opposite Quarantine station........................	40 36 52	74 03 00	80	—	—	Sandy clay	Polluted
436	May 6, 1909	About ¾ mile opposite Quarantine station......................	40 36 50	74 02 54	80	—	—	Sandy clay	Polluted
437	May 5, 1909	About 300 feet off Staten Island shore, 500 feet north of Quarantine.........................	40 36 45	74 03 39	50	Black	Oily	Sludge, subsoil	Doubtful

TABLE XIV—Continued

15—THE NARROWS—Continued

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
438	May 6, 1909	About 1000 feet off Staten Island shore, 500 feet north of Quarantine	40 36 47	74 03 29	50	Black	—	Sludge, subsoil	Doubtful
439	May 6, 1909	About 1600 feet off Staten Island shore, 500 feet north of Quarantine	40 36 47	74 03 20	50	—	Oily	Silt, sand	Doubtful
440	May 6, 1909	About ½ mile off Quarantine station	40 36 42	74 03 09	50	—	—	Sand	Unpolluted
441	May 6, 1909	About ½ mile off Staten Island shore, 500 feet north of Quarantine station	40 36 50	74 03 15	50	—	—	Silty sand	Polluted
442	May 6, 1909	About 3000 feet off Quarantine station	40 36 47	74 03 10	50	—	—	Sand, gravel	Polluted
443	May 6, 1909	About ¾ mile off Quarantine station	40 36 55	74 02 56	50	—	—	Sand, gravel	Polluted
444	May 7, 1909	Narrows, opposite Quarantine station about midstream	40 36 58	74 03 01	80	—	Oily	Sand, clay	Polluted
445	May 7, 1909	About 1000 feet off Ft. Wadsworth	40 36 21	74 03 10	80	Gray	—	Subsoil	Polluted
446	May 7, 1909	About 1300 feet off Ft. Wadsworth	40 36 25	74 03 05	80	Gray	Oily	Subsoil	Polluted
447	May 7, 1909	About ⅜ mile off Ft. Wadsworth	40 36 25	74 02 56	80	—	Oily	Sand	Polluted
448	May 7, 1909	Midway between Ft. Wadsworth and Ft. Lafayette	40 36 27	74 02 50	80	Brown	—	Subsoil	Polluted
449	May 7, 1909	About ¼ mile off Ft. Lafayette	40 36 30	74 02 41	80	Brown	Oily	Sludge, clay	Polluted
450	May 7, 1909	About 900 feet west of buoy, north of Ft. Lafayette	40 36 35	74 02 37	80	—	Oily	Sludge, clay	Polluted
451	May 7, 1909	About 50 feet east of buoy, north of Ft. Lafayette	40 36 33	74 02 26	10	Gray	Oily	Clay	Polluted
452	May 7, 1909	About 2000 feet off Quarantine pier	40 36 47	74 03 16	75	—	Oily	Sand, clay	Polluted

16—UPPER BAY

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
453	May 7, 1909	About ½ mile east of Constable Point	40 39 18	74 04 50	30	Gray	—	Subsoil	Polluted
454	May 7, 1909	About ¾ mile northeast of Constable Point	40 39 25	74 04 42	30	Gray	—	Clay	Polluted
455	May 7, 1909	About ⅞ mile northeast of Constable Point	40 39 33	74 04 35	30	Gray	—	Clay	Polluted
456	May 7, 1909	About one mile northeast of Constable Point	40 39 38	74 04 25	30	Gray	—	Clay	Polluted

17—NEWARK BAY AND PASSAIC RIVER

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
457	May 8, 1909	About ⅓ distance from Shooter's Island, toward Bergen Point light	40 38 38	74 09 13	20	—	—	Sand, gravel	Unpolluted
458	May 8, 1909	Lower end of Newark bay	40 38 58	74 09 02	20	—	Oily	Sand, gravel	Polluted
459	May 8, 1909	On line draw of C. R.R. of N. J. bridge and bell buoy above, 1000 feet above bridge	40 39 25	74 08 41	20	—	Oily	Sludge, clay	Polluted

TABLE XIV—Continued

17—NEWARK BAY AND PASSAIC RIVER—Continued

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude ° ′ ″	Longitude ° ′ ″					
460	May 8, 1909	Nearly halfway between draw of C. R.R. of N. J. bridge and bell buoy above	40 39 44	74 08 25	20	—	Oily	Silt	Polluted
461	May 8, 1909	Newark bay at bell buoy above C. R.R. of N. J. bridge	40 40 10	74 08 06	15	—	Oily	Sludge, clay	Polluted
462	May 8, 1909	Newark bay, near bell buoy above C. R.R. of N. J. bridge	40 40 37	74 07 51	15	—	Oily	Silt	Polluted
463	May 8, 1909	About 3000 feet south of buoy C 3	40 40 54	74 07 41	12	—	Oily	Sludge, clay	Polluted
464	May 8, 1909	Newark bay, 200 feet east of can buoy No. 3	40 41 22	74 07 45	12	—	Oily	Sludge, clay	Polluted
465	May 8, 1909	Newark bay, at can buoy No. 4	40 41 35	74 07 26	12	—	Oily	Sludge, sand	Polluted
466	May 8, 1909	About 1300 feet south of buoy N, above Lehigh Valley bridge	40 42 13	74 07 11	12	—	Oily	Sludge, sand	Doubtful
467	May 8, 1909	At buoy N, above Lehigh Valley Bridge	40 42 26	74 07 11	12	—	Oily	Sludge, sand	Polluted
468	May 8, 1909	Newark bay, 2000 feet below bridge 100 feet off shore New York and Newark	40 43 04	74 07 22	15	Gray	—	Clay	Unpolluted
469	May 8, 1909	Passaic river, 1000 feet above bridge 80 feet off shore New York and Newark	40 43 34	74 07 15	15	Gray	Oily	Subsoil	Polluted
470	May 8, 1909	Passaic river, 200 feet above Plank Road bridge, 80 feet off west shore	40 43 57	74 07 08	15	—	—	Sludge, sand	Polluted
471	May 8, 1909	Passaic river, 1000 feet above Plank Road bridge, midstream	40 44 08	74 07 02	15	—	Oily	Silty sand	Polluted
472	May 8, 1909	Newark bay, near mouth of Hackensack river	40 43 00	74 06 27	15	Gray	—	Sandy clay	Doubtful
473	May 8, 1909	At mouth of Hackensack river, 2300 feet below bridge	40 42 53	74 06 37	12	Gray	—	Sandy clay	Polluted
474	May 8, 1909	At mouth of Hackensack river, 2000 feet northeast of buoy N	40 42 42	74 06 52	15	Black	Oily	Sludgy clay	Polluted
475	May 8, 1909	Newark bay, 100 feet south of corner stake light	40 38 43	74 10 10	20	Gray	Oily	Subsoil	Polluted
476	May 8, 1909	Newark bay, 100 feet off southwest corner of Shooters Island	40 38 27	— — —	16	Gray	Oily	Clay	Polluted
477	May 8, 1909	Newark bay, 150 feet off southeast corner of Shooter's Island	40 38 27	74 09 20	20	Black	Oily	Clay	Polluted

18—HUDSON RIVER

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude ° ′ ″	Longitude ° ′ ″					
478	May 14, 1909	Hudson river, 300 feet off Pier 3, Hoboken	40 44 16	74 01 15	50	Gray	Oily	Subsoil	Polluted
479	May 14, 1909	Hudson river, 900 feet out from Pier 3, Hoboken	40 44 13	74 01 25	40	Gray	Oily	Subsoil	Polluted
480	May 14, 1909	Midstream, opposite Christopher street, Manhattan	40 42 58	74 01 15	40	Gray	Oily	Subsoil	Doubtful
481	May 14, 1909	1200 feet off Pier 45, Hudson river, Manhattan	40 43 57	74 00 58	40	Gray	—	Clay	——
482	May 14, 1909	About 600 feet off Pier 44, Hudson river, Manhattan	40 43 58	74 00 50	50	—	—	Sand, gravel	Polluted
483	May 14, 1909	600 feet out from Erie Pier A, Hoboken	40 45 31	74 01 13	35	Brown	—	Clay	Doubtful

TABLE XIV—Continued

18—HUDSON RIVER (Continued)

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
484	May 14, 1909	Opposite West 28th street, Manhattan, 1500 feet off New Jersey shore........................	40 45 35	74 01 00	35	Brown	—	Clay	Unpolluted
485	May 14, 1909	2500 feet off West 23d street, Manhattan........................	40 45 40	74 00 49	40	Brown	—	Clay	Doubtful
486	May 14, 1909	1500 feet off West 33d street, Manhattan........................	40 45 36	74 00 37	40	Gray	—	Clay	Unpolluted
487	May 14, 1909	500 feet off West 33d street, Manhattan........................	40 45 30	74 00 28	40	—	—	Sand, gravel	Unpolluted
488	May 14, 1909	Opposite West 72d street, Manhattan, 1000 feet off New Jersey shore........................	40 47 07	73 59 53	35	Gray	—	Subsoil	Polluted
489	May 14, 1909	2400 feet off West 74th street, Manhattan........................	40 47 08	73 59 39	40	Gray	—	Subsoil	——
490	May 14, 1909	Midstream, opposite West 72d street, Manhattan..............	40 47 02	73 59 42	40	Gray	Oily	Subsoil	——
491	May 14, 1909	1000 feet from 72d street, Pier, Manhattan, Hudson river.......	40 46 58	73 59 30	45	Gray	—	Subsoil	Unpolluted
492	May 14, 1909	900 feet from 72d street, Pier, Manhattan, Hudson river...........	40 46 57	73 59 29	40	Gray	—	Clay	Polluted
493	May 14, 1909	300 feet from 72d street, Pier, Manhattan, Hudson river...........	40 46 54	73 59 23	35	Black	Oily	Sludge, subsoil	Polluted
494	May 15, 1909	Opposite West 96th street, Manhattan, 500 feet off New Jersey shore........................	40 48 10	73 59 25	15	Gray	Oily	Subsoil	Doubtful
495	May 15, 1909	Opposite West 96th street, Manhattan, 1500 feet off New Jersey shore........................	40 48 04	73 59 13	20	Gray	Oily	Subsoil	Doubtful
496	May 15, 1909	Midstream, opposite West 96th street, Manhattan.............	40 48 00	73 59 03	50	Gray	Oily	Subsoil	Polluted
497	May 15, 1909	1400 feet off pier, West 96th street, Manhattan....................	40 47 55	73 58 53	50	Brown	—	Subsoil	Polluted
498	May 15, 1909	300 feet off pier, West 96th street, Manhattan....................	40 47 50	73 58 40	40	Brown	—	Clay	Doubtful
499	May 15, 1909	300 feet off West shore, opposite Ft. Washington Point..............	40 51 07	73 57 32	12	Gray, yellow	—	Clay	Unpolluted
500	May 15, 1909	Opposite Ft. Washington Point about ⅓ distance from west shore	40 51 05	73 57 21	20	Gray, yellow	—	Clay	Doubtful
501	May 15, 1909	Opposite Ft. Washington Point, about ⅔ across from west shore.	40 51 03	73 57 05	45	Black, yellow	—	Clay	Doubtful
502	May 15, 1909	400 feet out from Ft. Washington Point........................	40 51 02	73 56 56	80	—	—	Rock	——

19—LOWER BAY

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude						
			° ′ ″	° ′ ″						
503	May 17, 1909	By Gas buoy S2, near Coney Island...................	40 34 00	73 59 20	20	Black	—	Mud	Unpolluted	1,400,000
504	May 17, 1909	About ¾ mile south of buoy S2, off Coney Island........	40 33 25	73 59 25	15	Brown	—	Sand	Unpolluted	2,400

TABLE XIV—Continued

19—LOWER BAY—Continued

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude						
			° ′ ″	° ′ ″						
506	May 17, 1909	About 1 mile south of buoy S2, off Coney Island	40 33 10	73 59 30	15	Brown	—	Sand	Unpolluted	1,200
507	May 17, 1909	About 1½ miles south of buoy S2, off Coney Island	40 32 45	73 59 40	15	Brown	—	Sand	Unpolluted	800
508	May 17, 1909	About ⅞ mile north of A C buoy 14	40 32 10	73 59 35	20	Brown	—	Sand	Unpolluted	1,200
509	May 17, 1909	About ⅜ mile north of A C buoy 14	40 31 45	73 59 35	20	Brown	—	Sand	Doubtful	1,400
510	May 17, 1909	1000 feet north-northwest of A C buoy No. 12	40 31 15	73 59 10	20	Brown	—	Sand	Unpolluted	2,200
511	May 17, 1909	50 feet north of A C buoy No. 12	40 31 05	73 59 05	15	Brown	—	Sand	Unpolluted	900
513	May 18, 1909	In Ambrose channel, 100 feet feet south of A C buoy No. 12	40 31 00	73 59 00	40	Gray	—	Sand	Unpolluted	1,900
514	May 18, 1909	Midway between buoys A C No. 12 and N. B. No. 2	40 30 10	73 58 40	20	Brown	—	Sand	Unpolluted	——
515	May 18, 1909	100 feet north of N. B. buoy No. 2	40 29 30	73 58 25	20	Brown	—	Sand	Unpolluted	1,200
516	May 18, 1909	100 feet south of N. B. buoy No. 2, main channel	40 29 25	73 58 25	35	Brown	—	Sand	Unpolluted	——
517	May 18, 1909	100 feet south of buoy N 2½, main channel	40 29 10	73 59 20	40	Brown	—	Sand	Unpolluted	2,400
518	May 18, 1909	100 feet south of buoy N 4, main channel	40 29 00	74 00 20	40	Brown	—	Sand	Unpolluted	——
519	May 18, 1909	100 feet south of buoy N 6, main channel	40 29 00	74 00 40	50	Brown	—	Sand	Unpolluted	1,400
520	May 18, 1909	100 feet south of buoy N 8, main channel	40 28 45	74 01 20	40	Brown	—	Sand	Unpolluted	——
521	May 18, 1909	100 feet south of buoy N 10, main channel	40 28 35	74 02 05	40	Brown and Black	—	Sand	Unpolluted	50,000
522	May 18, 1909	100 feet south of buoy N 12, main channel	40 28 40	74 02 40	35	Gray	—	Sand, mud	Polluted	——
523	May 18, 1909	100 feet west of buoy N C 2, main channel	40 29 10	74 02 45	35	Gray	—	Mud	Polluted	600,000
524	May 18, 1909	100 feet west of buoy N C 4, main channel	40 29 40	74 02 40	35	Gray	—	Mud	Polluted	——
525	May 18, 1909	100 feet west of buoy N C 6, main channel	40 30 10	74 02 40	35	Gray	—	Mud	Polluted	1,200,000
526	May 18, 1909	100 feet west of buoy N C 8, main channel	40 30 40	74 02 35	35	Gray	—	Mud, sand	Polluted	——
527	May 18, 1909	100 feet west of buoy N, main channel	40 31 15	74 02 30	35	Gray	—	Mud	Polluted	1,800,000
528	May 18, 1909	100 feet east of buoy C 9, main channel	40 32 00	74 02 25	35	Gray	—	Mud	Polluted	——
529	May 18, 1909	100 feet east of buoy C 9½, main channel	40 33 00	74 02 25	35	Gray	—	Mud, sand	Polluted	2,400,000
530	May 18, 1909	100 feet east of buoy No. 11, main channel, lower bay	40 34 05	74 02 40	40	Gray	—	Mud, sand	Doubtful	——
531	May 18, 1909	50 feet east of Craven Shoal buoy	40 35 05	74 02 30	50	Gray	—	Mud	Doubtful	4,200,000
532	May 19, 1909	500 feet west of Craven Shoal buoy	40 35 40	74 02 35	30	Gray	—	Mud	Polluted	1,200,000
533	May 19, 1909	500 feet off flagstaff, South Beach, S. I.	40 35 00	74 04 20	10	Gray	—	Sand, mud	Doubtful	——
534	May 19, 1909	About 1¼ miles west of Swinburne Island	40 34 15	74 04 20	15	Gray	—	Mud	Unpolluted	800,000
535	May 19, 1909	On line West Bank light and Elm Tree beacon, 1 mile off Staten Island shore	40 33 20	74 04 50	15	Gray	—	Mud	Doubtful	——

TABLE XIV—Continued

19—LOWER BAY—Continued

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude						
			° ′ ″	° ′ ″						
536	May 19, 1909	About 2¼ miles west of West Bank light	40 32 45	74 05 00	15	Gray	—	Mud	Doubtful	1,100,000
537	May 19, 1909	About 1½ miles northeast of Old Orchard Shoal light	40 32 00	74 05 30	15	Brown & black	—	Sand	Polluted	——
538	May 19, 1909	About ¾ mile northeast of Old Orchard Shoal light	40 31 30	74 05 40	15	Brown & black	—	Sand	Polluted	600,000
539	May 19, 1909	100 feet north of Old Orchard light	40 30 50	74 05 50	20	Brown & black	—	Sand	Unpolluted	——
540	May 19, 1909	100 feet north of buoy "cable B and W" farthest north, lower bay	40 30 05	74 06 15	20	Gray	—	Mud	Doubtful	600,000
541	May 19, 1909	100 feet north of buoy "cable B and W" farthest south, lower bay	40 29 25	74 06 30	25	Gray	—	Mud	Doubtful	——
542	May 19, 1909	200 feet south of buoy S. I. W., lower bay	40 28 40	74 06 45	15	Brown black	—	Sand	Unpolluted	140,000
543	May 19, 1909	Halfway between Pt. Comfort beacon and buoy S. I. W.	40 27 50	74 06 55	15	Brown	—	Sand	Unpolluted	4,800
544	May 19, 1909	500 feet south of buoy 1½ off Seguine Point	40 30 20	74 10 45	15	Gray	—	Mud	Unpolluted	——
545	May 19, 1909	500 feet south of buoy N off Seguine Point	40 30 00	74 09 45	20	Gray	—	Mud	Unpolluted	400,000

20—EAST RIVER

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
546	May 29, 1909	Off spindle light at buoy No. 4 Sunken Meadow	40 47 24	73 54 51	70	Brown	—	Gravel	Unpolluted
547	May 29, 1909	At buoy No. 7 off Lawrence Point	40 47 34	73 54 31	60	Brown	—	Sand	Unpolluted
548	May 29, 1909	At buoy No. 5 off Lawrence Point	40 47 42	73 54 19	60	—	—	Rock	——
549	May 29, 1909	Midway between buoy 5 and light on North Brother Island	40 47 50	73 54 09	40	Black	Oily	Sludge	Polluted
550	May 29, 1909	At buoy No. 3 of North Brother Island	40 47 56	73 53 48	60	Black	Oily	Sludge, clay	Polluted
551	May 29, 1909	At red buoy 2½ off North Brother Island	40 48 17	73 53 40	80	Black	Oily	Sludge, clay	Polluted
554	June 5, 1909	1500 feet out from Riker's Island light	40 48 07	73 53 30	40	—	Oily	Sand, gravel	Polluted
555	June 5, 1909	In line Riker's Island light and Hunt's Point ⅓ distance	40 47 57	73 53 02	60	—	—	Rock	——
556	June 5, 1909	In line Riker's Island light and Hunt's Point ⅔ distance from light	40 48 01	73 52 45	75	—	—	Rock	——
557	June 5, 1909	900 feet off Hunt's Point in range with Riker's Island light	40 48 02	73 52 38	60	Black	Oily	Sludge	Polluted
558	June 5, 1909	Red spar buoy No. 2 off Hunt's Point	40 48 01	73 52 26	30	Gray	Oily	Clay	Polluted
559	June 5, 1909	100 feet from red spar buoy No. 2 off Hunt's Point	40 47 59	73 52 26	40	Gray	Oily	Subsoil	Polluted
560	June 5, 1909	1300 feet north of Riker's Island	40 47 45	73 52 05	40	Black	Oily	Sludge	Polluted
561	June 5, 1909	1500 feet northeast of Riker's Island	40 47 35	73 52 00	60	Black	Oily	Sludge, clay	Polluted
562	June 5, 1909	2400 feet off ferry slip College Point	40 47 30	73 51 50	15	Black	Oily	Sludge, clay	Polluted

TABLE XIV—Continued

20—EAST RIVER—Continued

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
563	June 5, 1909	2000 feet out from ferry slip College Point in line with red spar buoy No. 2, Hunt's Point	40 47 24	73 51 50	50	Gray	Oily	Clay	Polluted
564	June 5, 1909	800 feet out from ferry slip College Point in line with red spar buoy No. 2, Hunt's Point	40 47 15	73 51 40	40	Gray	Oily	Clay	Polluted
565	June 5, 1909	In bay between ferry slip College Point and northeast point of College Point	40 47 23	73 51 23	8	Gray	Oily	Clay	Polluted
566	June 5, 1909	At black spar buoy No. 1 off Clauson Point	40 47 53	73 51 05	15	—	—	Sludge	Polluted
567	June 5, 1909	1000 feet spar buoy No. 1 toward Clauson Point	40 48 03	73 51 08	60	Black	Oily	Sludge	Polluted
568	June 5, 1909	1000 feet off Clauson Point Casino dock	40 48 08	73 51 08	60	Black	Oily	Sludge, clay	Polluted
569	June 5, 1909	1000 feet out from trolley dock, Clauson Point	40 48 11	73 50 45	60	—	Oily	Silt, sand	Polluted
570	June 5, 1909	Midway between Tallman Island dock and Clauson Point	40 48 06	73 50 40	70	—	—	Rock	——
571	June 5, 1909	200 feet off Tallman Island block	40 47 54	73 50 27	25	Gray	—	Clay	Polluted
572	June 7, 1909	1000 feet off Tallman Island dock	40 48 00	73 50 16	60	Gray	Oily	Clay	Polluted
573	June 7, 1909	Midway between Old Ferry Point and Whitestone light	40 48 10	73 50 10	70	Gray	Oily	Clay	Polluted
574	June 7, 1909	1000 feet off Old Ferry Point in line with Whitestone light	40 48 14	73 49 43	90	Gray	Oily	Clay	Polluted
575	June 7, 1909	Half way between Whitestone Point and Old Ferry Point	40 48 10	73 49 33	70	Black	Oily	Sludge, clay	Polluted
576	June 7, 1909	About ⅔ way across from Old Ferry Point to Whitestone light	40 48 07	73 49 26	80	Black	Oily	Sludge, clay	Polluted
577	June 7, 1909	500 feet off Whitestone light in line with Old Ferry Point	40 48 04	73 49 17	70	Gray	Oily	Clay	Polluted
578	June 7, 1909	1600 feet off Whitestone Point	40 48 18	73 49 14	70	Gray	Oily	Clay	Polluted
579	June 7, 1909	2300 feet off Whitestone Point	40 48 24	73 49 15	90	Gray	Oily	Clay	Polluted
580	June 7, 1909	3000 feet off Whitestone Point	40 48 31	73 49 17	10	Gray	Oily	Clay	Polluted
581	June 7, 1909	1000 feet off shore from cupola in range with Whitestone light	40 48 36	73 49 17	70	Gray	—	Clay	Unpolluted

21—LONG ISLAND SOUND

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
582	June 8, 1909	1000 feet off Whitestone light in line with Ft. Schuyler light	40 48 04	73 48 59	50	Gray	Oily	Subsoil	Polluted
583	June 8, 1909	2200 feet off Whitestone light in line with Ft. Schuyler light	40 48 06	73 48 44	50	Gray	Oily	Subsoil	Polluted
584	June 8, 1909	3100 feet off Whitestone light in line with Ft. Schuyler light	40 48 08	73 48 32	50	Gray	Oily	Subsoil	Polluted
585	June 8, 1909	4000 feet off Whitestone light in line with Ft. Schuyler light	40 48 10	73 48 20	40	Gray	Oily	Subsoil	Polluted
586	June 8, 1909	3200 feet off Ft. Schuyler light in line with Whitestone light	40 48 11	73 48 15	50	Gray	Oily	Subsoil	Polluted
587	June 8, 1909	2200 feet off Ft. Schuyler light in line with Whitestone light	40 48 12	73 48 03	50	Gray	Oily	Subsoil	Polluted

TABLE XIV—Continued

21—LONG ISLAND SOUND—Continued

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
588	June 8, 1909	500 feet off Ft. Schuyler light in range with Whitestone light.....	40 48 16	73 47 42	50	Gray	—	Clay	Polluted
589	June 8, 1909	From Ft. Schuyler light to Stepping Stones light 1000 feet off shore..	40 48 32	73 47 21	30	—	—	Clay	Unpolluted
590	June 8, 1909	2500 feet from Ft. Schuyler light in line with Stepping Stones light..	40 48 44	73 47 10	50	—	—	Clay, sand	Unpolluted
591	June 8, 1909	4300 feet from Ft. Schuyler light in line with Stepping Stones light..	40 48 59	73 46 57	50	Gray	—	Clay	Unpolluted
592	June 8, 1909	1500 feet from Stepping Stones light in line with Ft. Schuyler light...	40 49 15	73 46 42	35	Brown	—	Clay	Unpolluted
593	June 8, 1909	1000 feet from Stepping Stones light in line with City Island.........	40 49 35	73 46 30	40	—	—	Sand, gravel	Unpolluted
594	June 8, 1909	2000 feet from Stepping Stones light in line with City Island.........	40 49 50	73 46 40	75	Black	H_2S	Clay	Unpolluted
595	June 8, 1909	3200 feet from Stepping Stones light in line with City Island........	40 50 00	73 46 40	80	Gray	H_2S	Subsoil	Unpolluted
596	June 8, 1909	100 feet off west point of City Island	40 50 15	73 46 50	25	—	—	Sludge, clay	Doubtful
597	June 8, 1909	700 feet west of Hawkins dock, south side of City Island........	40 50 25	73 46 40	20	—	—	——	——
598	June 8, 1909	500 feet off Hawkins dock south side, City Island..................	40 50 35	73 46 40	20	Gray	—	Clay	Unpolluted

22—LOWER BAY

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
599	June 12, 1909	300 feet off U. S. R.R. dock, below Sandy Hook light..............	40 26 50	74 00 15	6	Brown	—	Clay	Unpolluted
600	June 12, 1909	Along west shore, Sandy Hook....	40 27 10	74 00 25	5	White	—	Sand	Unpolluted
601	June 12, 1909	Along west shore, Sandy Hook....	40 27 20	74 00 35	5	White	—	Sand	Unpolluted
602	June 12, 1909	In cove, south of U. S. R.R. dock, Sandy Hook...................	40 26 45	73 59 55	15	—	—	Silty sand	Unpolluted
603	June 12, 1909	At spar, off south Beacon light, Sandy Hook...................	40 27 40	74 00 35	12	White	—	Sand	Unpolluted
604	June 12, 1909	1000 feet off dock, north of Life Saving Station.................	40 27 50	74 00 35	16	—	—	Sand	Unpolluted

23—EASTCHESTER BAY

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
605	June 14, 1909	200 feet off oil dock, City Island..	40 50 30	73 47 20	15	Gray	—	Clay	Unpolluted
606	June 14, 1909	2300 feet west of City Island......	40 50 25	73 47 40	18	Gray	—	Clay	Unpolluted
607	June 14, 1909	3500 feet west of City Island......	40 50 20	73 48 00	10	Gray	H_2S	Clay	Unpolluted
608	June 14, 1909	4500 feet west of City Island......	40 50 15	73 48 05	12	Gray	H_2S	Clay	Unpolluted
609	June 14, 1909	5000 feet west of City Island......	40 50 15	73 48 20	15	Gray	H_2S	Clay	Unpolluted
610	June 14, 1909	6000 feet west of City Island......	40 50 10	73 48 25	12	Gray	H_2S	Clay	Unpolluted

TABLE XIV—Continued

23—EASTCHESTER BAY—Continued

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
611	June 14, 1909	About 1⅜ miles west of City Island, 1000 feet off Westchester shore	40 50 05	73 48 40	12	Gray	H_2S	Clay	Unpolluted
612	June 14, 1909	About ⅜-mile off Westchester shore	40 49 50	73 48 20	12	Gray	H_2S	Clay	Unpolluted
613	June 14, 1909	About 1900 feet off Westchester shore	40 49 20	73 47 55	12	Gray	H_2S	Clay	Unpolluted
614	June 14, 1909	About 900 feet off Westchester shore, near Throgs Neck	40 49 00	73 47 40	12	Gray	—	Clay	Unpolluted

24—LITTLE NECK BAY

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
615	June 23, 1909	In Little Neck bay	40 47 30	73 45 30	8	Black	—	Mud	Unpolluted
616	June 23, 1909	Little Neck cove, at southeastern extremity of Little Neck bay	40 47 00	73 45 00	8	Black	—	Mud	Polluted
617	June 23, 1909	Mouth of Little Neck creek	40 46 00	73 45 00	3	Black	—	Mud	Unpolluted
618	June 23, 1909	In Little Neck bay	40 46 30	73 45 30	5	Black	—	Mud	Unpolluted
619	June 23, 1909	In Little Neck bay, near Willet's Point	40 46 30	73 45 50	8	Black	—	Mud	Unpolluted
620	June 23, 1909	At mouth of Little Neck bay	40 48 00	73 45 30	8	Black	—	Mud	Unpolluted
621	June 23, 1909	At mouth of Little Neck bay, near Willet's Point	40 47 40	73 46 00	9	Black	—	Mud	Unpolluted

25—EAST RIVER

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
622	June 23, 1909	100 feet off dock on Throgs Neck	40 48 19	73 47 44	50	Black	—	Mud	Unpolluted
623	June 23, 1909	¼ way across river from Throgs Neck	40 48 12	73 47 48	90	Black	—	Mud	Polluted
624	June 23, 1909	¾ way across river from Throgs Neck	40 47 56	73 47 56	70	Black	—	Mud	Polluted
625	June 23, 1909	100 feet off dock at Beechhurst, Whitestone	40 47 47	73 48 00	10	—	—	Mud	Doubtful

26—JAMAICA BAY

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude						
			° ′ ″	° ′ ″						
626	June 29, 1909	Jamaica bay, 100 feet off dock Belle Harbor, Beach channel	40 34 55	73 51 05	10	Gray	—	Sand	Unpolluted	12,000
627	June 29, 1909	Jamaica bay, 100 feet above drawbridge at Hammels	40 35 45	73 48 50	10	Gray	—	Silty sand	Unpolluted	900,000

TABLE XIV—Continued

26—JAMAICA BAY—Continued

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude						
			° ′ ″	° ′ ″						
628	June 29, 1909	30 feet off foot Bayswater avenue, Far Rockaway	40 36 30	73 46 15	6	Gray	—	Clay, gravel	Unpolluted	700,000
629	June 30, 1909	Jamaica bay at bridge Norton's creek, head of Bay Edgemere	40 36 00	73 46 10	10	Gray	—	Clay	Doubtful	1,000,000
630	June 30, 1909	100 feet off shore, opposite Arverne Sta., Jamaica bay	40 35 40	73 47 25	4	Black	—	Clay	Polluted	6,000,000
631	June 30, 1909	Jamaica bay, 1000 feet out from Arverne Sta.	40 36 05	73 47 20	4	Black	—	Clay	Doubtful	1,000,000
632	June 30, 1909	Jamaica bay, Cross channel, off Arverne	40 35 50	73 48 25	8	Gray	—	Clay	Doubtful	900,000
633	June 30, 1909	Jamaica bay, creek at foot of Pleasant avenue, Arverne	40 35 35	73 48 25	8	Gray	—	Sand, clay	Doubtful	1,200,000
634	June 30, 1909	Cross creek, along shore, near Park avenue, Arverne	40 35 30	73 48 20	8	—	—	——	Polluted	2,000,000
635	June 30, 1909	Jamaica bay, 100 feet off foot of Bannister avenue, Arverne	40 35 45	73 48 15	6	Black	—	Clay	Polluted	6,000,000
636	June 30, 1909	Yard of house near foot of Pleasant avenue	40 35 35	73 48 10	3	Gray	—	Clay	Doubtful	850,000
637	July 1, 1909	Jamaica bay, mouth of Fresh creek	40 38 30	73 52 55	3	Gray	—	Clay	Unpolluted	900,000
638	July 1, 1909	Jamaica bay, half-way up Fresh creek	40 38 50	73 53 20	3	Black	—	Clay	Unpolluted	1,200,000
639	July 1, 1909	Second creek, midway between mouth and sewer	40 39 05	73 53 00	4	—	—	Sludge	Polluted	12,000,000
640	July 1, 1909	At mouth of Second creek	40 38 55	73 52 40	4	Black	—	Clay	Polluted	9,000,000
641	July 1, 1909	Jamaica bay, 500 feet off mouth of Second creek	40 38 35	73 52 25	6	Black	—	Clay, gravel	Polluted	1,200,000
642	July 1, 1909	Jamaica bay, 500 feet off mouth of Fresh creek	40 38 25	73 52 30	6	Black	—	Sandy clay	Polluted	900,000
643	July 1, 1909	Jamaica bay, 500 feet off shore at Sandy bay, north of Canarsie	40 37 50	73 53 05	6	Black	—	Clay	Polluted	750,000
644	July 1, 1909	Jamaica bay creek, running through Canarsie	40 38 15	73 54 00	6	Black	—	Clay	Polluted	700,000
645	July 1, 1909	Jamaica bay, 100 feet off main landing, Canarsie	40 37 40	73 53 15	8	Black	—	Clay	Unpolluted	120,000
646	July 1, 1909	Halfway across Rockaway Inlet	40 34 15	73 53 55	40	—	—	——	——	8,000

27—HUDSON RIVER

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
647	July 7, 1909	Hudson river 100 feet off Mt. St. Vincent Station	40 54 50	73 54 45	10	Gray	—	Clay	Polluted
648	July 7, 1909	Hudson river 200 feet off Ludlow Station	40 55 27	73 54 30	10	Gray	—	Clay	Polluted
649	July 7, 1909	Hudson river 200 feet off Federal Sugar Plant	40 55 45	73 54 23	10	Gray	—	Clay	Polluted
650	July 7, 1909	200 feet off recreation pier, Yonkers	40 56 07	73 54 20	20	Black	Oily	Clay	Polluted
651	July 7, 1909	Hudson river 200 feet off Spuyten Duyvil drawbridge	40 52 43	73 55 37	20	—	—	Sand	Doubtful

TABLE XIV—Continued

28—GRAVESEND BAY

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
652	July 9, 1909	Gravesend bay foot of 22d street, Coney Island	40 34 45	73 59 26	4	Black	Putrid	Sludge	Polluted
653	July 9, 1909	Gravesend bay foot of 24th street, Coney Island	40 34 44	73 59 33	4	Black	Foul	Sand	Polluted
654	July 9, 1909	Gravesend bay by the breakwater north of entrance to Coney Island	40 35 00	73 59 30	6	—	—	Sand	Unpolluted

29—UPPER BAY

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
655	July 15, 1909	150 feet off Greenville shore	40 41 34	74 04 58	4	Gray	—	Subsoil	Unpolluted
656	July 15, 1909	200 feet off Greenville shore	40 41 31	74 04 50	4	Gray	—	Subsoil	Unpolluted
657	July 15, 1909	300 feet off Greenville shore	40 41 29	74 04 43	4	Gray	—	Subsoil	Unpolluted
658	July 15, 1909	400 feet off Greenville shore	40 41 25	74 04 40	4	Gray	—	Clay	Unpolluted
659	July 15, 1909	500 feet off Greenville shore	40 41 20	74 04 35	4	Gray	—	Clay	Unpolluted
660	July 15, 1909	600 feet off Greenville shore	40 41 17	74 04 27	4	Gray	—	Clay	Unpolluted
661	July 15, 1909	700 feet off Greenville shore	40 41 14	74 04 18	4	Gray	—	Clay	Unpolluted
662	July 15, 1909	1000 feet off Greenville shore	40 41 06	74 04 04	4	Gray	—	Clay	Unpolluted
663	July 15, 1909	1200 feet off Greenville shore	40 40 58	74 03 49	4	Gray	—	Clay	Unpolluted
664	July 15, 1909	100 feet off Greenville shore	40 41 22	74 05 08	4	Gray	—	Clay	Unpolluted
665	July 15, 1909	200 feet off Greenville shore	40 41 19	74 05 00	4	Gray	—	Clay	Unpolluted
666	July 15, 1909	300 feet off Greenville shore	40 41 12	74 04 53	4	Gray	—	Clay	Unpolluted
667	July 15, 1909	500 feet off Greenville shore	40 41 07	74 04 44	4	Gray	—	Clay	Unpolluted
668	July 15, 1909	700 feet off Greenville shore	40 41 00	74 04 36	4	Gray	—	Clay	Unpolluted
669	July 15, 1909	Near end of P. R.R. docks, Greenville	40 40 52	74 04 27	4	Gray	—	Clay	Unpolluted
670	July 15, 1909	At the end of P. R.R. docks, Greenville	40 40 49	74 04 19	20	Gray	—	Clay	Unpolluted
671	July 19, 1909	500 feet off Bayonne shore at Pamrapo	40 40 26	74 06 05	6	Gray	—	Subsoil	Unpolluted
672	July 19, 1909	1000 feet off Bayonne shore at Pamrapo	40 40 22	74 05 55	6	Gray	—	Subsoil	Unpolluted
673	July 19, 1909	2000 feet off Bayonne shore at Pamrapo	40 40 17	74 05 49	6	Black	—	Subsoil	Unpolluted
674	July 19, 1909	2500 feet off Bayonne shore at Pamrapo	40 40 14	74 05 42	6	Gray	—	Subsoil	Unpolluted
675	July 19, 1909	3000 feet off Bayonne shore at Pamrapo	40 40 12	74 05 35	6	Gray	—	Subsoil	Unpolluted
676	July 19, 1909	4000 feet off Bayonne shore at Pamrapo	40 40 07	74 05 24	6	Gray	—	Subsoil	Unpolluted
677	July 19, 1909	5000 feet off Bayonne shore at Pamrapo	40 40 02	74 05 13	6	Black	—	Subsoil	Unpolluted
678	July 19, 1909	6000 feet off Bayonne shore at Pamrapo	40 39 57	74 04 58	6	Gray	—	Subsoil	Unpolluted
679	July 19, 1909	7000 feet off Bayonne shore at Pamrapo	40 39 48	74 04 46	6	Black	Oily	Subsoil	Unpolluted
680	July 19, 1909	7500 feet off Bayonne shore at Pamrapo	40 39 43	74 04 36	6	Black	Oily	Subsoil	Unpolluted
681	July 19, 1909	1000 feet northwest of Robbins Reef	40 39 35	74 04 18	10	Black	Oily	Clay	Doubtful
682	July 19, 1909	100 feet off Bayonne shore at Pamrapo	40 40 18	74 06 23	6	Gray	—	Subsoil	Unpolluted

TABLE XIV—Continued

29—UPPER BAY—Continued

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
683	July 19, 1909	1000 feet off Bayonne shore at Pamrapo	40 40 16	74 06 13	6	Gray	Oily	Subsoil	Unpolluted
684	July 19, 1909	3000 feet off Bayonne shore at Pamrapo	40 40 10	74 06 01	6	Black	—	Subsoil	Unpolluted
685	July 19, 1909	3000 feet off Bayonne shore at Pamrapo	40 40 00	74 05 50	6	Gray	—	Subsoil	Unpolluted
686	July 19, 1909	4000 feet off Bayonne shore at Pamrapo	40 39 57	74 05 40	6	Gray	—	Subsoil	Unpolluted
687	July 19, 1909	5000 feet off Bayonne shore at Pamrapo	40 39 52	74 05 32	6	Gray	Oily	Subsoil	Unpolluted
688	July 19, 1909	6000 feet off Bayonne shore at Pamrapo	40 39 47	74 05 22	6	Gray	—	Subsoil	Unpolluted
689	July 19, 1909	7000 feet off Bayonne shore at Pamrapo	40 39 42	74 05 12	6	Gray	Oily	Subsoil	Unpolluted
690	July 19, 1909	8000 feet off Bayonne shore at Pamrapo	40 39 36	74 05 02	6	Gray	Oily	Subsoil	Unpolluted
691	July 19, 1909	2000 feet west of Robbins Reef	40 39 29	74 04 50	10	Gray	Oily	Subsoil	Doubtful
692	July 21, 1909	Off the end of P. R.R. dock at Greenville	40 40 27	74 04 02	18	Gray	—	Silty sand	Unpolluted
693	July 21, 1909	2000 feet off P. R.R. dock at Greenville	40 40 25	74 03 45	6	Gray	—	Subsoil	Doubtful
694	July 21, 1909	2500 feet off P. R.R. dock at Greenville	40 40 19	74 03 48	8	Gray	—	Subsoil	Unpolluted
695	July 21, 1909	2600 feet off P. R.R. dock at Greenville	40 40 13	74 03 47	10	—	—	Sandy clay	Polluted
696	July 21, 1909	3000 feet off P. R.R. dock at Greenville	40 40 07	74 03 41	10	Gray	—	Subsoil	Polluted
697	July 21, 1909	4000 feet off P. R.R. dock at Greenville	40 40 02	74 03 35	10	Gray	—	Sandy clay	Polluted
698	July 21, 1909	500 feet west of Robbins Reef	40 39 26	74 04 05	10	—	—	Rock	——
699	July 21, 1909	1000 feet northwest of Robbins Reef	40 39 38	74 04 06	10	Gray	—	Subsoil	Unpolluted
700	July 21, 1909	2000 feet northwest of Robbins Reef	40 39 45	74 04 16	10	Gray	Oily	Clay	Unpolluted
701	July 21, 1909	3000 feet northwest of Robbins Reef	40 39 51	74 04 20	10	Gray	Oily	Clay	Unpolluted
702	July 21, 1909	3500 feet northwest of Robbins Reef	40 39 57	74 04 22	10	Gray	Oily	Clay	Unpolluted
703	July 21, 1909	4000 feet northwest of Robbins Reef	40 40 02	74 04 25	10	Gray	—	Clay	Unpolluted
704	July 21, 1909	4500 feet northwest of Robbins Reef	40 40 07	74 04 25	10	Gray	Oily	Clay	Unpolluted
705	July 21, 1909	5000 feet northwest of Robbins Reef	40 40 15	74 04 28	8	Gray	—	Clay	Unpolluted
706	July 21, 1909	6000 feet northwest of Robbins Reef	40 40 20	74 04 33	6	Gray	—	Clay	Unpolluted
707	July 21, 1909	At south side of P. R.R. dock Reef	40 40 31	74 04 42	5	Gray	—	Clay	Unpolluted

30—LOWER BAY

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude						
			° ′ ″	° ′ ″						
708	July 21, 1909	Sandy Hook, near Shrewsbury river	40 47 50	74 01 25	30	Black	Marshy	Clay	Polluted	60,000
709	July 21, 1909	Shrewsbury river at Spermaceti Cove	40 24 55	73 59 35	8	Brown	None	Sand, gravel	Unpolluted	4,800
710	July 21, 1909	Shrewsbury river at Seabright	40 21 55	73 58 40	8	Brown	None	Sand, gravel	Unpolluted	6,000
711	July 21, 1909	Sandy Hook bay in Horseshoe	40 26 45	73 59 50	20	Brown	None	Sand	Unpolluted	2,600
712	July 21, 1909	Sandy Hook bay, west of point of hook	40 28 35	74 01 25	30	Brown	None	Sand	Unpolluted	3,600

TABLE XIV—Continued

30—LOWER BAY—Continued

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude						
			° ′ ″	° ′ ″						
713	July 21, 1909	Lower bay, in main ship channel by buoy No. 8..........	40 28 45	74 01 25	40	Brown	None	Sand	Unpolluted	3,200
714	July 21, 1909	Half way between buoy No. 8 and Romer light............	40 29 50	74 01 00	40	Brown	None	Sand	Unpolluted	2,800
715	July 21, 1909	50 feet inside Coney Island channel, near bell buoy.....	40 34 15	73 59 50	20	Brown	None	Sand	Unpolluted	2,800
716	July 21, 1909	Coney Island channel, by bell buoy off Sea Gate Inn......	40 34 05	73 59 50	30	Black	Sewage	Sand	Unpolluted	1,000,000
717	July 21, 1909	On East bank...............	40 32 25	73 59 45	10	Brown	None	Sand	Unpolluted	2,400
718	July 21, 1909	In fourteen foot channel......	40 31 50	74 00 25	20	Black	Sewage	Mud	Polluted	1,800,000
719	July 21, 1909	On Romer shoals............	40 31 20	74 00 35	15	Brown	None	Sand	Unpolluted	2,100
720	July 21, 1909	In Swash channel, 700 feet southwest of Romer light...	40 30 40	74 00 50	30	Black	Sewage	Mud	Polluted	1,200,000
721	July 21, 1909	In Swash channel, 500 feet northeast of black and red buoy......................	40 31 20	74 02 15	30	Black	Sewage	Mud	Polluted	1,600,000
722	July 21, 1909	In Main Ship channel, west of buoy at junction of Swash and Main channel..........	40 31 20	74 02 30	40	Black	Sewage	Mud	Polluted	2,000,000
723	July 21, 1909	500 feet west of West Bank light......................	40 32 15	74 02 45	20	Brown	Marshy	Sand, clay	Doubtful	600,000
724	July 21, 1909	Half way between West Bank light and Elm Tree beacon.	40 33 05	73 04 10	15	Brown	None	Sand	Unpolluted	6,000
725	July 21, 1909	1000 feet off Elm Tree Beacon	40 33 45	74 05 30	10	Brown	None	Sand	Unpolluted	4,800

31—ATLANTIC OCEAN

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude						
			° ′ ″	° ′ ″						
726	July 21, 1909	Atlantic ocean, in so-called "Mud Gorge" about 10 miles east of Long Branch........	40 19 15	73 48 45	145	Green	Marshy	Silt	Unpolluted	6,400
727	July 21, 1909	Atlantic ocean, in so-called "Mud Gorge" 10 miles off Long Branch..............	40 19 15	73 48 45	145	Green	Marshy	Silt	Unpolluted	5,600
728	July 21, 1909	Atlantic ocean, about 12 miles due east of Long Branch, easterly edge of "Mud Gorge"...................	40 19 15	73 47 15	150	Green	Marshy	Silt	Unpolluted	4,800
729	July 21, 1909	Atlantic ocean, about 12 miles due east of Long Branch, easterly edge of "Mud Gorge"...................	40 19 15	73 47 15	150	Green	Marshy	Silt	Unpolluted	7,200
730	July 21, 1909	"Oil Spot" on false Sandy Hook, 100 feet east of spar buoy 54	40 27 00	73 58 25	20	Brown	None	Sand	Unpolluted	2,800
731	July 21, 1909	"Oil Spot" on false Sandy Hook, 1000 feet east of spar buoy S4	40 27 05	73 58 25	20	Brown	None	Sand	Unpolluted	1,600

TABLE XIV—Continued

32—HUDSON RIVER

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude						
			° ′ ″	° ′ ″						
732	Aug. 19, 1909	Half way across the Hudson on a line with Pier 1	40 42 23	74 01 35	50	Black	Sewage	Mud	Doubtful	1,000,000
733	Aug. 19, 1909	Half way across Hudson, opposite Pier 17	40 43 00	74 01 25	40	—	—	Gravel	Unpolluted	——
734	Aug. 19, 1909	50 feet off end of Pier 17, Hudson river	40 42 56	74 01 01	40	Gray	Sewage	Mud	Polluted	1,300,000
735	Aug. 19, 1909	Hudson river, half way across from Pier 32	40 43 34	74 01 19	40	Gray	—	Clay	Polluted	630,000
736	Aug. 19, 1909	Hudson river, half way across from Pier 48	40 44 08	74 01 11	40	Gray	—	Clay	Polluted	750,000
737	Sept. 7, 1909	Hudson River, 500 feet off foot West 72d street	40 46 54	73 59 25	35	Black	—	Mud	Polluted	——
738	Sept. 7, 1909	Hudson river, 500 feet off foot of West 110th street	40 48 23	73 58 18	40	Black	—	Mud	Unpolluted	——
739	Sept. 7, 1909	Hudson river, 500 feet off foot of 140th street	40 49 31	73 57 27	40	Blue	—	Clay	Unpolluted	——
740	Sept. 7, 1909	Hudson river, 500 feet off Washington Point	40 51 02	73 56 56	40	—	—	Gravel	Unpolluted	——
741	Sept. 7, 1909	Hudson river, 500 feet off Inwood bathing beach	40 52 17	73 55 56	40	Gray	—	Mud	Polluted	——
742	Sept. 7, 1909	Hudson river, 500 feet off Spuyten Duyvil creek	40 52 44	73 55 40	40	—	—	Gravel	Unpolluted	——
743	Sept. 7, 1909	Hudson river, 500 feet off Federal Refining Plant, Yonkers	40 55 45	73 54 23	40	Gray	—	Gravel, mud	Unpolluted	——
744	Sept. 7, 1909	Hudson river, 500 feet off Power Plant, northern limit of Yonkers	40 56 52	73 54 07	35	Brown	—	Sand	Unpolluted	——

33—PASSAIC RIVER AND NEWARK BAY

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
745	Sept. 8, 1909	Passaic river, 200 feet below P. R.R. passenger bridge, Newark	40 45 14	74 09 55	15	Black	Oily	Mud	Polluted
746	Sept. 8, 1909	Passaic river, 100 feet above P.R.R. freight bridge, below Newark	40 44 09	74 09 45	15	Black	—	Mud	Polluted
747	Sept. 8, 1909	Passaic river, 100 feet below N. Y. and Newark R.R. bridge	40 43 21	74 07 20	15	Blue	—	Clay	Unpolluted
748	Sept. 8, 1909	Newark bay, 100 feet below Lehigh Valley Bridge	40 41 54	74 07 12	15	Blue	—	Clay	Unpolluted
749	Sept. 8, 1909	Newark bay, 200 feet west of red bell buoy, off Centreville	40 40 12	74 08 08	15	Blue	—	Clay	Polluted
750	Sept. 8, 1909	Newark bay, 100 feet below C. R.R. of N. J. bridge	40 39 14	74 08 49	15	—	—	Sand	Unpolluted

TABLE XIV—Continued

34—KILL VAN KULL

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
751	Sept. 8, 1909	Kill van Kull, west end, 1000 feet east of lighthouse	40 38 35	74 08 45	35	—	—	Gravel	——
752	Sept. 8, 1909	Kill van Kull, midstream, opposite Sailors' Snug Harbor station	40 38 50	74 05 55	40	—	—	Sand, gravel	Unpolluted
753	Sept. 8, 1909	Kill van Kull, east end, opposite end of Constable Hook, midstream	40 39 05	74 05 10	40	—	—	Sand, gravel	Unpolluted
754	Sept. 11, 1909	Kill van Kull, midstream, off Sailors' Snug Harbor	40 38 50	74 05 55	40	—	—	Gravel	Unpolluted
755	Sept. 11, 1909	Kill van Kull, midstream, off Port Richmond	40 38 36	74 07 52	40	—	—	Sand	Polluted
756	Sept. 11, 1909	Kill van Kull, west end, 500 feet south of Shooters' Island	40 38 25	74 09 30	35	—	—	Gravel, sand	Unpolluted

35—LOWER BAY

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
757	Sept. 13, 1909	Lower bay, 200 feet southeast of Ambrose channel, buoy No. 24	40 33 30	74 01 25	35	Gray	—	Sand	Unpolluted
758	Sept. 13, 1909	Lower bay, 1500 feet east of Ambrose channel, No. 20	40 32 25	74 00 45	25	Black	Sewage, H_2S	Mud	Doubtful
759	Sept. 13, 1909	Lower bay, 500 feet northeast of Ambrose channel, buoy No. 10	40 31 00	73 58 45	20	Gray	—	Sand	Unpolluted
760	Sept. 13, 1909	Lower bay, about 1000 feet north of Ambrose channel, buoy No. 4	40 30 20	73 57 00	20	Gray	—	Sand	Unpolluted
761	Sept. 13, 1909	Lower bay, 100 feet northeast of Ambrose channel, buoy No. 4	40 30 10	73 56 55	35	Gray	—	Sand	Unpolluted
762	Sept. 13, 1909	Lower bay, 100 feet south of Ambrose channel, buoy No. 3	40 29 55	73 57 05	20	Brown	—	Sand	Unpolluted
763	Sept. 13, 1909	Lower bay, 100 feet north of buoy G 6	40 29 30	73 57 20	30	Brown	—	Sand	Polluted
764	Sept. 13, 1909	Lower bay, midway between G 6 and G 5	40 29 25	73 57 20	35	Black	—	Sand	Unpolluted
765	Sept. 13, 1909	Lower bay, 200 feet south of buoy G 5	40 29 10	73 57 20	30	Brown	—	Gravel	Unpolluted
766	Sept. 13, 1909	Lower bay, 100 feet south of buoy C. B. 1 off Sandy Hook	40 29 15	73 58 15	30	Brown	—	Sand	Unpolluted
767	Sept. 13, 1909	Lower bay, 500 feet southeast of buoy C. B. 3 off Sandy Hook	40 28 50	73 59 10	35	Brown	—	Sand	Unpolluted
768	Sept. 13, 1909	Lower bay, main ship's channel, 1000 feet northeast of buoy N 8	40 28 55	74 01 20	35	Gray	—	Sand	Unpolluted
769	Sept. 13, 1909	Lower bay, 500 feet southwest of buoy C. S. 1, south of Swash channel	40 29 35	74 00 30	35	Brown	—	Sand	Unpolluted
770	Sept. 14, 1909	Lower bay, 200 feet east of West Bank light	40 32 20	74 02 30	35	Black	—	Mud, sand	Polluted
771	Sept. 14, 1909	Lower bay, between 2 buoys at junction of Swash and main channels	40 31 25	74 02 20	30	Black	—	Mud, sand	Polluted
772	Sept. 14, 1909	Lower bay, 300 feet northeast of buoy C. S. 3	40 30 50	74 01 45	20	Black	H_2S	Mud	Polluted
773	Sept. 14, 1909	Lower bay, 500 feet south of Romer light	40 30 45	74 00 45	30	Gray	—	Mud	Doubtful

TABLE XIV—Continued

35—LOWER BAY—Continued

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
774	Sept. 14, 1909	Lower bay, 500 feet south of buoy N. S. 4	40 30 00	73 59 45	30	Brown	—	Sand	Unpolluted
775	Sept. 14, 1909	Lower bay, 500 feet north of buoy C. S. 1	40 29 45	74 00 30	25	Brown	—	Sand	Unpolluted
776	Sept. 14, 1909	Lower bay, 500 feet northwest of buoy N. S. 2	40 29 50	73 59 20	25	Brown	—	Sand	Unpolluted
777	Sept. 14, 1909	Lower bay, 500 feet southeast of black buoy S 9	40 30 45	73 58 45	20	Gray	—	Sand	Unpolluted
778	Sept. 14, 1909	Lower bay, 500 feet northwest of red buoy S 10	40 31 00	73 58 55	25	Gray	—	Sand	Unpolluted
779	Sept. 14, 1909	Lower bay, ⅓ distance between buoy A. C. 8 and Manhattan Beach	40 32 05	73 57 40	20	Gray	—	Sand	Unpolluted
780	Sept. 14, 1909	Lower bay, ⅔ distance between buoy A. C. 8 and Manhattan Beach	40 33 05	73 57 25	22	Brown	—	Sand	Unpolluted

36—ARTHUR KILL

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
781	Sept. 16, 1909	Rahway river, ½ mile from mouth	40 35 55	74 12 45	8	Black	—	Mud	Unpolluted
782	Sept. 16, 1909	Arthur Kill, opposite mouth of Rahway river	40 35 35	74 12 15	10	Black	Oily	Mud	Doubtful
783	Sept. 16, 1909	Arthur Kill, opposite Fresh Kills	40 34 45	74 12 35	15	Black	—	Sand	Unpolluted
784	Sept. 16, 1909	Arthur Kill, by buoy S. 6, north of Rahway river	40 35 45	74 12 05	12	Black	—	Mud, sand	Unpolluted
785	Sept. 16, 1909	Arthur Kill, by buoy S. 4, at east end of Kill	40 38 45	74 10 45	15	Black	—	Mud, sand	Polluted
786	Sept. 16, 1909	Kill van Kull, between Shooter's Island and Mariners' Harbor	40 28 35	74 09 30	35	Black	—	Mud	Doubtful

37—LOWER BAY

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude						
			° ′ ″	° ′ ″						
787	Sept. 20, 1909	Lower bay, 500 feet southwest West Bank light	40 32 10	74 02 40	20	Brown	Marshy	Sand	Polluted	——
788	Sept. 20, 1909	Lower bay, about 1 mile from West Bank light in line with Port Monmouth	40 31 25	74 03 00	20	Black	Sewage	Mud	Polluted	——
789	Sept. 20, 1909	Lower bay, near white buoy S. on same line	40 30 20	74 03 15	20	Brown	None	Sand	Unpolluted	——
790	Sept. 20, 1909	Lower bay, farther north on same line	40 29 35	74 03 25	25	Brown	None	Sand	Doubtful	——
791	Sept. 20, 1909	Lower bay, 1000 feet west of buoy C. C. 1	40 28 35	74 03 15	25	Black	Marshy	Sand	Polluted	530,000
792	Sept. 20, 1909	Lower bay, farther south on same line	40 27 40	74 02 40	20	Brown	—	Sand	Polluted	230,000

TABLE XIV—Continued

37—LOWER BAY—Continued

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude						
			° ′ ″	° ′ ″						
793	Sept. 20, 1909	Lower bay, about 1 mile off Atlantic Highlands.........	40 26 25	74 03 15	20	Black	—	Sand, mud	Polluted	320,000
794	Sept. 20, 1909	Lower bay, about ½ mile off Atlantic Highlands.........	40 25 50	74 03 25	18	Brown	—	Sand, mud	Polluted	240 000
795	Sept. 20, 1909	Lower bay, 2000 feet west of buoy S. 1 W. off Point Comfort......................	40 29 00	74 07 50	12	Brown	—	Sand	Unpolluted	360,000
796	Sept. 20, 1909	Lower bay, nearer Great Kills.	40 29 50	74 07 40	25	Black	—	Mud	Unpolluted	230,000
797	Sept. 20, 1909	Lower bay, 1½ miles south of Great Kills................	40 30 35	74 07 40	15	Brown	—	Sand	Unpolluted	1,000,000
798	Sept. 20, 1909	Lower bay, 1 mile south of Great Kills................	40 31 10	74 07 45	10	Brown	—	Sand	Unpolluted	150,000

38—RARITAN BAY

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude						
			° ′ ″	° ′ ″						
799	Sept. 21, 1909	Raritan bay, off Seguine Point, 1000 feet east of buoy S. 3..	40 30 30	74 01 05	20	Black	—	Mud	Doubtful	——
800	Sept. 21, 1909	Raritan bay, by buoy S. 3 in Seguine channel...........	40 30 30	74 11 25	25	—	—	Gravel	——	——
801	Sept. 21, 1909	Raritan bay, 1000 feet southeast of Princess bay light...	40 30 20	74 12 35	20	Black	—	Mud	Doubtful	300,000
802	Sept. 21, 1909	Raritan bay, by red buoy S. 6.	40 29 45	74 13 35	25	Black	—	Mud	Doubtful	450,000
803	Sept. 21, 1909	Raritan bay, by red buoy S. 8.	40 29 05	74 14 20	25	Black	—	Mud	Doubtful	380,000
804	Sept. 21, 1909	Raritan bay, 500 feet north of Great Beds light...........	40 29 15	74 15 15	16	—	—	Clinkers	——	——

39—ARTHUR KILL

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude						
			° ′ ″	° ′ ″						
805	Sept. 21, 1909	Arthur Kill, 200 feet west of buoy S...................	40 30 10	74 15 40	20	Brown	—	Mud	Unpolluted	490,000
806	Sept. 21, 1909	Arthur Kill, 200 feet west of buoy 2, at Tottenville, S. I..	40 30 55	74 15 15	20	—	—	Clinkers	——	——

40—HUDSON RIVER

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude						
			° ′ ″	° ′ ″						
807	Oct. 1, 1909	Hudson river, 150 feet out from Pier 4....................	40 42 46	74 01 07	40	Black	Sewage	Gravel	Polluted	200,000

TABLE XIV—Continued

41—HARLEM RIVER

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude						
			° ′ ″	° ′ ″						
808	Oct. 11, 1909	Harlem river, opposite East 116th street, midstream.....	40 47 37	73 55 47	20	Gray	Gas house Oily	Mud	Polluted	150,000
809	Oct. 11, 1909	Harlem river, opposite East 116th street, 50 feet off Manhattan shore..............	40 47 38	73 55 50	20	Gray	Gas house	Mud	Polluted	380,000
810	Oct. 11, 1909	Harlem river, opposite East 110th street, midstream....	40 47 25	73 56 03	20	Black	H_2S	Mud	Polluted	300,000
811	Oct. 11, 1909	Harlem river, opposite East 110th street, 50 feet off Manhattan shore..............	40 47 26	73 56 06	20	Black	H_2S	Mud	Polluted	——

42—EAST RIVER

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude						
			° ′ ″	° ′ ″						
812	Oct. 1, 1909	East river, 1000 feet off mouth of Newtown Creek.........	40 44 13	73 57 57	30	Black	Oily, gas house	Sand	Polluted	1,300,000
813	Oct. 1, 1909	East river, 1000 feet off mouth of Newtown Creek.........	40 44 13	73 57 57	30	Black	Oily, gas house	Cinders	Doubtful	——
814	Oct. 1, 1909	East river, outer edge of Wallabout bay..................	40 42 25	73 58 30	30	Black	Oily, H_2S	Mud	Polluted	1,100,000
815	Oct. 1, 1909	East river, 200 feet outside Wallabout Canal...........	40 42 16	73 58 13	15	Black	Oily, H_2S	Mud	Polluted	450,000

43—HUDSON RIVER

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude						
			° ′ ″	° ′ ″						
816	Oct. 2, 1909	Hudson river, 30 feet south of outer southwest corner of Pier A.....................	40 42 15	74 01 08	40	Black	Sewage	Mud	Polluted	750,000

44—HARLEM RIVER

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude						
			° ′ ″	° ′ ″						
817	Oct. 2, 1909	Harlem river, opposite East 103d street, midstream....	40 47 09	73 56 15	25	Black	H_2S	Mud	Polluted	650,000
818	Oct. 2, 1909	Harlem river, opposite East 105th street, midstream.....	40 47 13	73 56 12	25	Black	H_2S	Mud	Polluted	——
819	Oct. 2, 1909	Harlem river, opposite East 108th street, midstream.....	40 47 21	73 56 08	25	Black	H_2S	Mud	Polluted	1,700,000

TABLE XIV—Continued

45—NEWTOWN CREEK

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
820	Oct. 2, 1909	Newtown Creek, 100 feet below first bridge	40 44 21	73 57 21	20	Black	—	Gravel	Polluted

46—UPPER BAY

No.	Date of Collection	Location of Samples			Depth in feet		Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude	Water	Mud					
			° ′ ″	° ′ ″							
821	Oct. 4, 1909.	By buoy S. A., off Gowanus bay	40 39 43	74 01 20	30	0	Black	Oily H_2S	Mud	Polluted	700,000
822	Oct. 4, 1909.	By buoy S. A., off Gowanus bay	40 39 43	74 01 20	30	1	Black	H_2S	Sand	Unpolluted	300,000
823	Oct. 4, 1909.	By buoy S. A., off Gowanus bay	40 39 43	74 01 20	30	2	Black	H_2S	Mud, sand	Doubtful	600,000
824	Oct. 4, 1909.	By buoy S. A., off Gowanus bay	40 39 43	74 01 20	30	3	Gray	H_2S	Clay	Unpolluted	750,000
825	Oct. 4, 1909.	By buoy S. A., off Gowanus bay	40 29 43	74 01 20	30	4	Gray	H_2S	Clay	Doubtful	900,000
826	Oct. 4, 1909.	By buoy S. A., off Gowanus bay	40 39 43	74 01 20	30	5	Gray	H_2S	Clay	Unpolluted	2,500,000
827	Oct. 4, 1909.	By buoy S. A., off Gowanus bay	40 39 43	74 01 20	30	6	Gray	H_2S	Clay, sand	Doubtful	2,000,000
828	Oct. 4, 1909.	By buoy S. A., off Gowanus bay	40 39 43	40 39 20	30	7	Gray	—	Clay, sand	Doubtful	900,000
829	Oct. 4, 1909.	By buoy S. A., off Gowanus bay	40 39 43	74 01 20	30	8	Gray	—	Clay, sand	Polluted	1,000,000
830	Oct. 4, 1909.	By buoy S. A., off Gowanus bay	40 39 43	74 01 20	30	9	Gray	—	Clay, sand	Unpolluted	500,000
831	Oct. 4, 1909.	By buoy S. A., off Gowanus bay	40 39 43	74 01 20	30	10	Gray	—	Clay, sand	Doubtful	600,000

47—GOWANUS CANAL

No.	Date of Collection	Location of Samples			Depth in feet		Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude	Water	Mud					
			° ′ ″	° ′ ″							
832	Oct. 4, 1909.	Gowanus Canal, at foot of Clinton street	40 39 57	74 00 25	20	0	Black	Gas	Mud	Polluted	3,000,000
833	Oct. 4, 1909.	Gowanus Canal, at foot of Clinton street	40 39 57	74 00 25	20	1	Black	Gas	Mud	Polluted	1,700,000
834	Oct. 4, 1909.	Gowanus Canal, at foot of Clinton street	40 39 57	74 00 25	20	2	Black	Gas	Mud	Polluted	1,900,000
835	Oct. 4, 1909.	Gowanus Canal, at foot of Clinton street	40 39 57	74 00 25	20	3	Black	Gas	Mud	Polluted	600,000
836	Oct. 4, 1909.	Gowanus Canal, at foot of Clinton street	40 39 57	74 00 25	20	4	Black	Gas	Mud	Polluted	310,000
837	Oct. 4, 1909.	Gowanus Canal, at foot of Clinton street	40 39 57	74 00 25	20	5	Black	Gas	Mud	Polluted	450,000

TABLE XIV—Continued

48—UPPER BAY

No.	Date of Collection	Location of Samples			Depth in feet		Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude	Water	Mud					
			° ′ ″	° ′ ″							
838	Oct. 6, 1909.	Upper bay, 50 feet south of buoy N 14..............	40 40 33	74 02 10	20	0	Black	H_2S	Mud, sand	Polluted	500,000
839	Oct. 6, 1909.	Upper bay, 50 feet south of buoy N 14..............	40 40 33	74 02 10	20	1	Black	H_2S	Mud, sand	Polluted	330,000
840	Oct. 6, 1909.	Upper bay, 50 feet south of buoy N 14..............	40 40 33	74 02 10	20	2	Black	H_2S	Mud, sand	Polluted	200,000
841	Oct. 6, 1909.	Upper bay, 50 feet south of buoy N 14..............	40 40 33	74 02 10	20	3	Gray	H_2S	Sand	Unpolluted	320,000
842	Oct. 6, 1909.	Upper bay, 50 feet south of buoy N 14..............	40 40 33	74 02 10	20	4	Gray	—	Sand	Unpolluted	250,000
843	Oct. 6, 1909.	Upper bay, in Red Hook channel, 30 feet off Pier 46	40 40 20	74 01 10	30	0	Black	Gas house, H_2S	Mud	Polluted	1,500,000
844	Oct. 6, 1909.	Upper bay, in Red Hook channel, 30 feet off Pier 46	40 40 20	74 01 10	30	1	Black	H_2S	Mud	Polluted	410,000
845	Oct. 6, 1909.	Upper bay, in Red Hook channel, 30 feet off Pier 46	40 40 20	74 01 10	30	2	Black	H_2S	Mud	Polluted	330,000
846	Oct. 6, 1909.	Upper bay, in Red Hook channel, 30 feet off Pier 46	40 40 20	74 01 10	30	3	Black	H_2S	Mud	Polluted	440,000
847	Oct. 6, 1909.	Upper bay, in Red Hook channel, 30 feet off Pier 46	40 40 20	74 01 10	30	4	Black	H_2S	Mud	Polluted	1,000,000
848	Oct. 6, 1909.	Upper bay, in Red Hook channel, 30 feet off Pier 46	40 40 20	74 01 10	30	5	Black	H_2S	Mud	Polluted	2,000,000
849	Oct. 6, 1909.	Upper bay, in Red Hook channel, 30 feet off Pier 46	40 40 20	74 01 10	30	6	Black	H_2S	Mud	Polluted	300,000
850	Oct. 6, 1909.	Upper bay, in Red Hook channel, 30 feet off Pier 46	40 40 20	74 01 10	30	7	Black	H_2S	Mud	Polluted	500,000
851	Oct. 6, 1909.	Upper bay, in Red Hook channel, 30 feet off Pier 46	40 40 20	74 01 10	30	8	Black	H_2S	Mud, sand	Polluted	700,000
852	Oct. 6, 1909.	Upper bay, in Red Hook channel, 30 feet off Pier 46	40 40 20	74 01 10	30	9	Black	H_2S	Mud, sand	Polluted	250,000
853	Oct. 7, 1909.	Upper bay, 30 feet east of bell buoy No. 12½.......	40 38 22	74 03 13	25	0	Black	H_2S	Mud	Polluted	450,000
854	Oct. 7, 1909.	Upper bay, 30 feet east of bell buoy No. 12½.......	40 38 22	74 03 13	25	1	Black	H_2S	Mud	Polluted	1,200,000
855	Oct. 7, 1909.	Upper bay, 30 feet east of bell buoy No. 12½.......	40 38 22	74 03 13	25	2	Black	H_2S	Mud	Unpolluted	200,000
856	Oct. 7, 1909.	Upper bay, 30 feet east of bell buoy No. 12½.......	40 38 22	74 03 13	25	3	Black	H_2S	Mud	Unpolluted	300,000
857	Oct. 7, 1909.	Upper bay, 30 feet east of bell buoy No. 12½.......	40 38 22	74 03 13	25	4	Black	H_2S	Mud	Unpolluted	400,000
858	Oct. 7, 1909.	Upper bay, 30 feet east of bell buoy No. 12½.......	40 38 22	74 03 13	25	5	Gray	H_2S	Mud, sand	Unpolluted	600,000
859	Oct. 7, 1909.	Upper bay, 30 feet east of bell buoy No. 12½.......	40 38 22	74 03 13	25	6	Gray	H_2S	Mud, sand	Unpolluted	200,000
860	Oct. 7, 1909.	Upper bay, 30 feet east of bell buoy No. 12½.......	40 38 22	74 03 13	25	7	Gray	H_2S	Mud, sand	Unpolluted	260,000
861	Oct. 7, 1909.	Upper bay, 30 feet east of bell buoy No. 12½.......	40 38 22	74 03 13	25	8	Gray	H_2S	Mud, sand	Unpolluted	210,000

TABLE XIV—Continued

48—UPPER BAY—Continued

No.	Date of Collection	Location of Samples			Depth in feet		Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude	Water	Mud					
			° ′ ″	° ′ ″							
862	Oct. 7, 1909.	Upper bay, 20 feet south of end of new ferry dock, Stapleton, S. I.	40 37 37	74 04 09	26	0	Black	H_2S	Mud	Polluted	400,000
863	Oct. 7, 1909.	Upper bay, 20 feet south of end of new ferry dock, Stapleton, S. I.	40 37 37	74 04 09	26	3	Black	H_2S	Mud	Doubtful	150,000
864	Oct. 7, 1909.	Upper bay, 20 feet south of end of new ferry dock, Stapleton, S. I.	40 37 37	74 04 09	26	4	Black	H_2S	Mud	Doubtful	250,000
865	Oct. 7, 1909.	Upper bay, 20 feet south of end of new ferry dock, Stapleton, S. I.	40 37 37	74 04 09	26	5	Black	H_2S	Mud	Doubtful	380,000
866	Oct. 7, 1909.	Upper bay, 20 feet south of end of new ferry dock, Stapleton, S. I.	40 37 37	74 04 09	26	6	Gray	H_2S	Clay, sand	Doubtful	110,000
867	Oct. 7, 1909.	Upper bay, 20 feet south of end of new ferry dock, Stapleton, S. I.	40 37 37	74 04 09	26	7	Gray	H_2S	Clay, sand	Unpolluted	800,000
868	Oct. 7, 1909.	Upper bay, 20 feet south of end of new ferry dock, Stapleton, S. I.	40 37 37	74 04 09	26	8	Gray	H_2S	Clay, sand	Unpolluted	200,000
869	Oct. 7, 1909.	Upper bay, 20 feet south of end of new ferry dock, Stapleton, S. I.	40 37 37	74 04 09	26	9	Gray	H_2S	Clay, sand	Unpolluted	130,000
870	Oct. 7, 1909.	Upper bay, 20 feet south of end of new ferry dock, Stapleton, S. I.	40 37 37	74 04 09	26	10	Gray	H_2S	Clay, sand	Unpolluted	210,000
871	Oct. 8, 1909.	Upper bay, midway between Robbins Reef light and Owl Head	40 38 54	74 03 06	32	0	Black	H_2S	Mud	Doubtful	300,000
872	Oct. 8, 1909.	Upper bay, midway between Robbins Reef light and Owl Head	40 38 54	74 03 06	32	1	Black	H_2S	Mud	Unpolluted	130,000
873	Oct. 8, 1909.	Upper bay, midway between Robbins Reef light and Owl Head	40 38 54	74 03 06	32	2	Gray	H_2S	Clay	Unpolluted	220,000
874	Oct. 8, 1909.	Upper bay, midway between Robbins Reef light and Owl Head	40 38 54	74 03 06	32	3	Gray	H_2S	Clay	Unpolluted	300,000
875	Oct. 8, 1909.	Upper bay, midway between Robbins Reef light and Owl Head	40 38 54	74 03 06	32	4	Gray	H_2S	Clay	Unpolluted	250,000
876	Oct. 8, 1909.	Upper bay, midway between Robbins Reef light and Owl Head	40 38 54	74 03 06	32	5	Gray	H_2S	Clay	Unpolluted	170,000
877	Oct. 8, 1909.	Upper bay, midway between Robbins Reef light and Owl Head	40 38 54	74 03 06	32	6	Gray	H_2S	Clay	Unpolluted	190,000
878	Oct. 8, 1909.	Upper bay, midway between Robbins Reef light and Owl Head	40 38 54	74 03 06	32	7	Gray	H_2S	Clay	Unpolluted	——
879	Oct. 8, 1909.	Upper bay, midway between Robbins Reef light and Owl Head	40 38 54	74 03 06	32	8	Gray	H_2S	Clay	Unpolluted	——
880	Oct. 8, 1909.	Upper bay, midway between Robbins Reef light and Owl Head	40 38 54	74 03 06	32	9	Gray	H_2S	Clay	Unpolluted	——
881	Oct. 8, 1909.	Upper bay, midway between Robbins Reef light and Owl Head	40 38 54	74 03 06	32	10	Gray	H_2S	Clay	Unpolluted	——

TABLE XIV—Continued

49—KILL VAN KULL

No.	Date of Collection	Location of Samples			Depth in feet		Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude	Water	Mud				
			° ′ ″	° ′ ″						
882	Oct. 8, 1909.	Kill van Kull, 50 feet off dock at ferry, Port Richmond, S. I......	40 38 30	74 07 53	20	0	Black	H_2S	Mud	Polluted
883	Oct. 8, 1909.	Kill van Kull, 50 feet off dock at ferry, Port Richmond, S. I......	40 38 30	74 07 53	20	1	Black	H_2S	Mud	Polluted
884	Oct. 8, 1909.	Kill van Kull, 50 feet off dock at ferry, Port Richmond, S. I......	40 38 30	74 07 53	20	2	Black	H_2S	Mud	Polluted
885	Oct. 8, 1909	Kill van Kull, 50 feet off dock at ferry, Port Richmond, S. I......	40 38 30	74 07 53	20	3	Black	H_2S	Mud	Polluted
886	Oct. 8, 1909	Kill van Kull, 50 feet off dock at ferry, Port Richmond, S. I......	40 38 30	74 07 53	20	4	Black	H_2S	Mud	Polluted
887	Oct. 8, 1909.	Kill van Kull, 50 feet off dock at ferry, Port Richmond, S. I......	40 38 30	74 07 53	20	5	Black	H_2S	Mud	Polluted
888	Oct. 8, 1909.	Kill van Kull, 50 feet off dock at ferry, Port Richmond, S. I......	40 38 30	74 07 53	20	6	Black	H_2S	Mud	Polluted
889	Oct. 8, 1909.	Kill van Kull, 50 feet off dock at ferry, Port Richmond, S. I......	40 38 30	74 07 53	20	7	Black	H_2S	Mud	Polluted
890	Oct. 8, 1909.	Kill van Kull, 50 feet off dock at ferry, Port Richmond, S. I......	40 38 30	74 07 53	20	8	Black	H_2S	Mud	Polluted
891	Oct. 8, 1909.	Kill van Kull, 50 feet off dock at ferry, Port Richmond, S. I......	40 38 30	74 07 53	20	9	Black	H_2S	Mud	Polluted
892	Oct. 8, 1909.	Kill van Kull, 50 feet off dock at ferry, Port Richmond, S. I......	40 38 30	74 07 53	20	10	Black	H_2S	Mud	Polluted
893	Oct. 8, 1909.	Kill van Kull, 50 feet off dock at ferry, Port Richmond, S. I......	40 38 30	74 07 53	20	11	Black	H_2S	Mud	Polluted

50—UPPER BAY

No.	Date of Collection	Location of Samples			Depth in feet		Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude	Water	Mud					
			° ′ ″	° ′ ″							
894	Oct. 11, 1909	Upper bay, 50 feet east of red buoy off Ellis Island	40 41 50	74 02 07	35	0	Black	H_2S	Mud, sand	Polluted	800,000
895	Oct. 11, 1909	Upper bay, 50 feet east of red buoy off Ellis Island	40 41 50	74 02 07	35	1	Black	H_2S	Mud	Polluted	700,000
896	Oct. 11, 1909	Upper bay, 50 feet east of red buoy off Ellis Island	40 41 50	74 02 07	35	2	Black	H_2S	Mud	Polluted	700,000
897	Oct. 11, 1909	Upper bay, 50 feet east of red buoy off Ellis Island	40 41 50	74 02 07	35	3	Black	H_2S	Mud	Polluted	3,000,000
898	Oct. 11, 1909	Upper bay, 50 feet east of red buoy off Ellis Island	40 41 50	74 02 07	35	4	Black	H_2S	Mud	Polluted	1,500,000
899	Oct. 11, 1909	Upper bay, 50 feet east of red buoy off Ellis Island	40 41 50	74 02 07	35	5	Black	H_2S	Mud	Unpolluted	3,000,000
900	Oct. 11, 1909	Upper bay, 50 feet east of red buoy off Ellis Island	40 41 50	74 02 07	35	6	Black	H_2S	Mud	Unpolluted	450,000
901	Oct. 11, 1909	Upper bay, 50 feet east of red buoy off Ellis Island	40 41 50	74 02 07	35	7	Black, gray	H_2S	Mud, clay	Unpolluted	530,000
902	Oct. 11, 1909	Upper bay, 50 feet east of red buoy off Ellis Island	40 41 50	74 02 07	35	8	Black, gray	H_2S	Mud, clay	—	300,000
903	Oct. 11, 1909	Upper bay, ½ mile west of Robbins Reef	40 39 24	74 04 14	15	0	Black	Oil, H_2S	Mud	Polluted	3,000,000

TABLE XIV—Continued

50—UPPER BAY—Continued

No.	Date of Collection	Location of Samples			Depth in feet		Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude	Water	Mud					
			° ′ ″	° ′ ″							
904	Oct. 11, 1909	Upper bay, ½ mile west of Robbins Reef	40 39 24	74 04 14	15	1	Black	H_2S	Mud, sand	Unpolluted	1,500,000
905	Oct. 11, 1909	Upper bay, ½ mile west of Robbins Reef	40 39 24	74 04 14	15	2	Brown	Marshy	Sand	Unpolluted	1,600,000
906	Oct. 11, 1909	Upper bay, ½ mile west of Robbins Reef	40 39 24	74 04 14	15	3	Brown	Marshy	Sand	Unpolluted	——

51—KILL VAN KULL

No.	Date of Collection	Location of Samples			Depth in feet		Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude	Water	Mud					
			° ′ ″	° ′ ″							
907	Oct. 11, 1909	Kill van Kull, opposite Livingston St., S. I.	40 38 44	74 06 40	35	0	Black	Sewage	Mud	Polluted	500,000
908	Oct. 11, 1909	Kill van Kull, opposite Livingston St., S. I.	40 38 44	74 06 40	35	1	Black	Kerosene	Mud	Polluted	900,000
909	Oct. 11, 1909	Kill van Kull, opposite Livingston St., S. I.	40 38 44	74 06 40	35	2	Black	Kerosene	Mud	Polluted	900,000
910	Oct. 11, 1909	Kill van Kull, opposite Livingston St., S. I.	40 38 44	74 06 40	35	3	Black	Kerosene	Mud	Polluted	1,800,000
911	Oct. 11, 1909	Kill van Kull, opposite Livingston St., S. I.	40 38 44	74 06 40	35	4	Black	Kerosene	Mud	Unpolluted	170,000
912	Oct. 11, 1909	Kill van Kull, opposite Livingston St., S. I.	40 38 44	74 06 40	35	5	Gray	H_2S	Sand	Unpolluted	320,000
913	Oct. 11, 1909	Kill van Kull, opposite Livingston street, S. I.	40 38 44	74 06 40	35	6	Gray	H_2S	Sand	Unpolluted	480,000
914	Oct. 11, 1909	Kill van Kull, opposite Livingston street, S. I.	40 38 44	74 06 40	35	7	Gray	H_2S	Sand	Unpolluted	180,000
915	Oct. 11, 1909	Kill van Kull, opposite Livingston street, S. I.	40 38 44	74 06 40	35	8	Gray	H_2S	Sand	Unpolluted	——

52—ARTHUR KILL

No.	Date of Collection	Location of Samples			Depth of Water (feet)	Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude						
			° ′ ″	° ′ ″						
916	Oct. 14, 1909	Arthur Kill, 200 feet east of drawbridge at Elizabethport	40 38 20	74 11 35	—	Gray	Sewage	Clay	Doubtful	320,000

TABLE XIV—Continued

53—NEWARK BAY

No.	Date of Collection	Location of Samples			Depth in feet		Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude	Water	Mud					
			° ′ ″	° ′ ″							
917	Oct. 14, 1909	Newark bay, 50 feet off Singer pier, Elizabethport.	40 39 10	74 10 11	12	0	Black	H_2S	Mud	Polluted	680,000
918	Oct. 14, 1909	Newark bay, 50 feet off Singer pier, Elizabethport.	40 39 10	74 10 11	12	1	Black	H_2S	Mud	Polluted	170,000
919	Oct. 14, 1909	Newark bay, 50 feet off Singer pier, Elizabethport.	40 39 10	74 10 11	12	2	Black	H_2S	Mud	Polluted	340,000
920	Oct. 14, 1909	Newark bay, 50 feet off Singer pier, Elizabethport.	40 39 10	74 10 11	12	3	Black	H_2S	Mud	Polluted	140,000
921	Oct. 14, 1909	Newark bay, 50 feet off Singer pier, Elizabethport.	40 39 10	74 10 11	12	4	Black	H_2S	Mud	Polluted	——
922	Oct. 14, 1909	Newark bay, 50 feet off Singer pier, Elizabethport.	40 39 10	74 10 11	12	5	Black	H_2S	Mud	Polluted	480,000
923	Oct. 14, 1909	Newark bay, 50 feet off Singer pier, Elizabethport.	40 39 10	74 10 11	12	6	Black	H_2S	Mud	Polluted	160,000
924	Oct. 14, 1909	Newark bay, 50 feet off Singer pier, Elizabethport.	40 39 10	74 10 11	12	7	Black	H_2S	Mud	Polluted	240,000
925	Oct. 14, 1909	Newark bay, 50 feet off Singer pier, Elizabethport.	40 39 10	74 10 11	12	8	Black	H_2S	Mud	Polluted	140,000
926	Oct. 14, 1909	Newark bay, 50 feet off Singer pier, Elizabethport.	40 39 10	74 10 11	12	9	Black	H_2S	Mud	Polluted	230,000
927	Oct. 14, 1909	Newark bay, 50 feet off Singer pier, Elizabethport.	40 39 10	74 10 11	12	10	Black	H_2S	Mud	Polluted	300,000
928	Oct. 14, 1909	Newark bay, 50 feet off Singer pier, Elizabethport.	40 39 10	74 10 11	12	11	Black	H_2S	Mud	Polluted	120,000
929	Oct. 14, 1909	Newark bay, midway between Shooter's Island and Corner Stake light.......	40 38 49	74 10 11	18	0	Black	Oily, H_2S	Mud	Polluted	——
930	Oct. 14, 1909	Newark bay, midway between Shooter's Island and Corner Stake light.......	40 38 49	74 10 11	18	1	Black	H_2S	Mud	Polluted	2,000,000
931	Oct. 14, 1909	Newark bay, midway between Shooter's Island and Corner Stake light.......	40 38 49	74 10 11	18	2	Black	H_2S	Mud	Polluted	1,800,000
932	Oct. 14, 1909	Newark bay, midway between Shooter's Island and Corner Stake light.......	40 38 49	74 10 11	18	3	Black	H_2S	Mud	Polluted	3,000,000
933	Oct. 14, 1909	Newark bay, midway between Shooter's Island and Corner Stake light.......	40 38 49	74 10 11	18	4	Black	H_2S	Mud	Polluted	1,600,000
934	Oct. 14, 1909	Newark bay, midway between Shooter's Island and Corner Stake light.......	40 38 49	74 10 11	18	5	Black	H_2S	Mud	Polluted	1,700,000
935	Oct. 14, 1909	Newark bay, midway between Shooter's Island and Corner Stake light.......	40 38 49	74 10 11	18	6	Black	H_2S	Mud	Polluted	900,000
936	Oct. 14, 1909	Newark bay, midway between Shooter's Island and Corner Stake light.......	40 38 49	74 10 11	18	7	Black	H_2S	Mud	Polluted	2,100,000
937	Oct. 15, 1909	Newark bay, 300 feet south of C. R.R. of N. J. bridge.	40 39 13	74 08 45	12	0	Black	Sewage	Mud	Polluted	880,000
938	Oct. 15, 1909	Newark bay, 300 feet south of C. R.R. of N. J. bridge.	40 39 13	74 08 45	12	1	Black	H_2S	Mud	Polluted	1,100,000
939	Oct. 15, 1909	Newark bay, 300 feet south of C. R.R. of N. J. bridge.	40 39 13	74 08 45	12	2	Black	H_2S	Mud	Polluted	1,400,000
940	Oct. 15, 1909	Newark bay, 300 feet south of C. R.R. of N. J. bridge.	40 39 13	74 08 45	12	3	Gray	H_2S	Clay	Unpolluted	200,000
941	Oct. 15, 1909	Newark bay, 300 feet south of C. R.R. of N. J. bridge.	40 39 13	74 08 45	12	4	Gray	H_2S	Clay	Unpolluted	700,000

TABLE XIV—Continued

53—NEWARK BAY—Continued

No.	Date of Collection	Location of Samples			Depth in feet		Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude	Water	Mud					
			° ′ ″	° ′ ″							
942	Oct. 15, 1909	Newark bay, midway between red bell buoy and Centreville shore	40 40 07	74 07 53	8	0	Gray	Marshy	Clay	Doubtful	750,000
943	Oct. 15, 1909	Newark bay, midway between red bell buoy and Centreville shore	40 40 07	74 07 53	8	1	Gray	Marshy	Clay	Unpolluted	300,000
944	Oct. 15, 1909	Newark bay, midway between red bell buoy and Centreville shore	40 40 07	74 07 53	8	2	Gray	Marshy	Clay	Doubtful	300,000
945	Oct. 15, 1909	Newark bay, midway between red bell buoy and Centreville shore	40 40 07	74 07 53	8	3	Gray	Marshy	Clay	Unpolluted	470,000
946	Oct. 15, 1909	Newark bay, 200 feet east of black buoy C 3	40 41 21	74 07 38	12	0	Black	H_2S	Sand	Polluted	1,200,000
947	Oct. 15, 1909	Newark bay, 200 feet east of black buoy C 3	40 41 21	74 07 38	12	1	Black	Marshy	Sand, mud	Polluted	900,000
948	Oct. 15, 1909	Newark bay, 200 feet east of black buoy C 3	40 41 21	74 07 38	12	2	Gray	Marshy	Clay	Unpolluted	750,000
949	Oct. 15, 1909	Newark bay, 200 feet east of black buoy C 3	40 41 21	74 07 38	12	3	Gray	Marshy	Clay	Unpolluted	300,000
950	Oct. 15, 1909	Newark bay, 200 feet east of black buoy C 3	40 41 21	74 07 38	12	4	Gray	Marshy	Clay	Unpolluted	480,000
951	Oct. 15, 1909	Newark bay, 200 feet east of black buoy C 3	40 41 21	74 07 38	12	5	Gray	Marshy	Clay	Unpolluted	800,000
952	Oct. 15, 1909	Newark bay, 200 feet east of black buoy C 3	40 41 21	74 07 38	12	6	Gray	Marshy	Clay	Unpolluted	——
953	Oct. 15, 1909	Newark bay, 200 feet east of black buoy C 3	40 41 21	74 07 38	12	7	Gray	Marshy	Clay	Unpolluted	420,000
954	Oct. 15, 1909	Newark bay, 200 feet east of black buoy C 3	40 41 21	74 07 38	12	8	Gray	Marshy	Clay	Unpolluted	560,000
955	Oct. 15, 1909	Newark bay, 200 feet east of black buoy C 3	40 41 21	74 07 38	12	9	Gray	Marshy	Clay	Unpolluted	420,000
956	Oct. 15, 1909	Newark bay, 200 feet east of black buoy C 3	40 41 21	74 07 38	12	10	Gray	Marshy	Clay	Unpolluted	——
957	Oct. 15, 1909	Newark bay, 100 feet west of red and black buoy N, above L. V. R.R. bridge	40 42 25	74 07 11	16	0	Black	H_2S	Mud	Polluted	——
958	Oct. 15, 1909	Newark bay, 100 feet west of red and black buoy N	40 42 25	74 07 11	16	1	Black	H_2S	Mud	Polluted	——
959	Oct. 15, 1909	Newark bay, 100 feet west of red and black buoy N	40 42 25	74 07 11	16	2	Black	H_2S	Mud	Polluted	——
960	Oct. 15, 1909	Newark bay, 100 feet west of red and black buoy N	40 42 25	74 07 11	16	3	Black	H_2S	Mud	Polluted	——
961	Oct. 15, 1909	Newark bay, 100 feet west of red and black buoy N	40 42 25	74 07 11	16	4	Black	H_2S	Mud	Polluted	——
962	Oct. 15, 1909	Newark bay, 100 feet west of red and black buoy N	40 42 25	74 07 11	16	5	Black	H_2S	Mud	Polluted	——

54—KILL VAN KULL

No.	Date of Collection	Location of Samples			Depth in feet		Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude	Water	Mud				
			° ′ ″	° ′ ″						
962	Oct. 16, 1909	Kill van Kull, pier head line off Bodine creek	40 38 28	74 07 39	12	0	Black	Sewage	Mud	Polluted
964	Oct. 16, 1909	Kill van Kull, pier head line off Bodine creek	40 38 28	74 07 39	12	1	Black	H_2S	Mud	Polluted

TABLE XIV—Continued

54—KILL VAN KULL—Continued

No.	Date of Collection	Location of Samples			Depth in feet		Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude	Water	Mud				
			° ′ ″	° ′ ″						
965	Oct. 16, 1909	Kill van Kull, pier head line off Bodine creek..................	40 38 28	74 07 39	12	2	Black	H_2S	Mud	Polluted
966	Oct. 16, 1909	Kill van Kull, pier head line off Bodine creek..................	40 38 28	74 07 39	12	3	Black	H_2S	Mud	Polluted
967	Oct. 16, 1909	Kill van Kull, pier head line off Bodine creek..................	40 38 28	74 07 39	12	4	Black	H_2S	Mud	Polluted
968	Oct. 16, 1909	Kill van Kull, pier head line off Bodine creek..................	40 38 28	74 07 39	12	5	Black	H_2S	Mud	Polluted
969	Oct. 16, 1909	Kill van Kull, pier head line off Bodine creek..................	40 38 28	74 07 39	12	6	Black	H_2S	Mud	Polluted
970	Oct. 16, 1909	Kill van Kull, pier head line off Bodine creek..................	40 38 28	74 07 39	12	7	Black	H_2S	Mud	Polluted
971	Oct. 16, 1909	Kill van Kull, pier head line off Bodine creek..................	40 38 28	74 07 39	12	8	Black	H_2S	Mud	Polluted
972	Oct. 16, 1909	Kill van Kull, pier head line off Bodine creek..................	40 38 28	74 07 39	12	9	Black	H_2S	Mud	Polluted

55—UPPER BAY

No.	Date of Collection	Location of Samples			Depth in feet		Color	Odor	Consistency	Opinion
		Approximate	Latitude	Longitude	Water	Mud				
			° ′ ″	° ′ ″						
973	Oct. 18, 1909	Upper bay, 400 feet south of Port Liberty coal dock..............	40 42 10	74 02 15	10	0	Black	Sewage	Mud, clay	Polluted
974	Oct. 18, 1909	Upper bay, 400 feet south of Port Liberty coal dock..............	40 42 10	74 02 15	10	1	Black	Sewage	Mud	Polluted
975	Oct. 18, 1909	Upper bay, 400 feet south of Port Liberty coal dock..............	40 42 10	74 02 15	10	2	Black	Sewage	Mud	Polluted
976	Oct. 18, 1909	Upper bay, 400 feet south of Port Liberty coal dock..............	40 42 10	74 02 15	10	3	Gray	Marshy	Clay	Polluted
977	Oct. 18, 1909	Upper bay, 400 feet south of Port Liberty coal dock..............	40 42 10	74 02 15	10	4	Gray	Marshy	Clay	Doubtful
978	Oct. 18, 1909	Upper bay, 400 feet south of Port Liberty coal dock..............	40 42 10	74 02 15	10	5	Gray	Marshy	Clay	Doubtful
979	Oct. 18, 1909	Upper bay, 400 feet south of Port Liberty coal dock..............	40 42 10	74 02 15	10	6	Gray	Marshy	Clay	Unpolluted
980	Oct. 18, 1909	Upper bay, 400 feet south of Port Liberty coal dock..............	40 42 10	74 02 15	10	7	Gray	Marshy	Clay	Unpolluted
981	Oct. 18, 1909	Upper bay, 400 feet south of Port Liberty coal dock..............	40 42 10	74 02 15	10	8	Gray	Marshy	Clay	Unpolluted
982	Oct. 18, 1909	Upper bay, 400 feet south of Port Liberty coal dock..............	40 42 10	74 02 15	10	9	Gray	Marshy	Clay	Unpolluted

56—HUDSON RIVER

No.	Date of Collection	Location of Samples			Depth in feet		Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude	Water	Mud					
			° ′ ″	° ′ ″							
983	Oct. 18, 1909	Hudson river, end of pier, 10th street, Hoboken.....	40 44 54	74 01 24	20	0	Black	Sewage	Mud	Polluted	1,200,000
984	Oct. 18, 1909	Hudson river, end of pier, 10th street, Hoboken.....	40 44 54	74 01 24	20	1	Black	H_2S	Mud	Polluted	1,800,000

TABLE XIV—Continued

56—HUDSON RIVER—Continued

No.	Date of Collection	Location of Samples			Depth in feet		Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude	Water	Mud					
			° ′ ″	° ′ ″							
985	Oct. 18, 1909	Hudson river, end of pier, 10th street, Hoboken.....	40 44 54	74 01 24	20	2	Black	H_2S	Mud	Polluted	2,000,000
986	Oct. 18, 1909	Hudson river, end of pier, 10th street, Hoboken.....	40 44 54	74 01 24	20	3	Black	H_2S	Mud	Polluted	1,800,000
987	Oct. 18, 1909	Hudson river, end of pier, 10th street, Hoboken.....	40 44 54	74 01 24	20	4	Black	H_2S	Mud	Polluted	2,000,000
988	Oct. 18, 1909	Hudson river, end of pier, 10th street, Hoboken.....	40 44 54	74 01 24	20	5	Black	H_2S	Mud	Polluted	2,400,000
989	Oct. 18, 1909	Hudson river, end of pier, 10th street, Hoboken.....	40 44 54	74 01 24	20	6	Black	H_2S	Mud	Polluted	2,000,000
990	Oct. 18, 1909	Hudson river, end of pier, 10th street, Hoboken.....	40 44 54	74 01 24	20	7	Black	H_2S	Mud	Polluted	1,800,000
991	Oct. 18, 1909	Hudson river, end of pier, 10th street, Hoboken.....	40 44 54	74 01 24	20	8	Black	H_2S	Mud	Polluted	1,000,000
992	Oct. 18, 1909	Hudson river, end of pier, 10th street, Hoboken.....	40 44 54	74 01 24	20	9	Black	H_2S	Mud	Polluted	1,200,000
993	Oct. 18, 1909	Hudson river, end of pier, 10th street, Hoboken.....	40 44 54	74 01 24	20	10	Black	H_2S	Mud	Polluted	1,600,000

57—NEWARK BAY

No.	Date of Collection	Location of Samples			Depth in feet		Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude	Water	Mud					
			° ′ ″	° ′ ″							
994	Oct. 21, 1909	Newark bay, 100 feet south of C. R.R. of N. J. bridge.	40 39 15	74 08 22	15	0	Black	H_2S	Mud, sand	Polluted	2,400,000
995	Oct. 21, 1909	Newark bay, 100 feet south of C. R.R. of N. J. bridge.	40 39 15	74 08 22	15	1	Black	H_2S	Mud, sand	Polluted	2,000,000
996	Oct. 21, 1909	Newark bay, 1000 feet south of C. R.R. of N. J. bridge.	40 39 05	74 08 36	8	0	Black	H_2S	Sand, mud	Polluted	1,800,000
997	Oct. 21, 1909	Newark bay, 1000 feet south of C. R.R. of N. J. bridge.	40 39 05	74 08 36	8	1	Black	H_2S	Sand, mud	Polluted	1,200,000
998	Oct. 21, 1909	Newark bay, 400 feet south of C. R.R. of N. J. bridge, 2000 feet from Elizabethport shore...............	40 39 13	74 09 45	12	0	Black	H_2S	Mud	Polluted	2,000,000
999	Oct. 21, 1909	Newark bay, 400 feet south of C. R.R. of N. J. bridge, 2000 feet from Elizabethport shore...............	40 39 13	74 09 45	12	1	Black	H_2S	Mud	Polluted	1,800,000
1000	Oct. 21, 1909	Newark bay, 400 feet south of C. R.R. of N. J. bridge, 2000 feet from Elizabethport shore...............	40 39 13	74 09 45	12	2	Black	H_2S	Mud, clay	Polluted	800,000
1001	Oct. 21, 1909	Newark bay, 400 feet south of C. R.R. of N. J. bridge, 2000 feet from Elizabethport shore...............	40 39 13	74 09 45	12	3	Gray	H_2S	Clay	Unpolluted	250,000
1002	Oct. 21, 1909	Newark bay, 400 feet south of C. R.R. of N. J. bridge, 2000 feet from Elizabethport shore...............	40 39 13	74 09 45	12	4	Gray	None	Clay	Unpolluted	130,000

TABLE XIV—Continued

57—NEWARK BAY—Continued

No.	Date of Collection	Location of Samples			Depth in feet		Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude	Water	Mud					
			° ′ ″	° ′ ″							
1003	Oct. 21, 1909	Newark bay, 400 feet south of C. R.R. of N. J. bridge, 2000 feet from Elizabethport shore	40 39 13	74 09 45	12	5	Gray	None	Clay	Unpolluted	120,000
1004	Oct. 21, 1909	Newark bay, 400 feet south of C. R.R. of N. J. bridge, 2000 feet from Elizabethport shore	40 39 13	74 09 45	12	6	Gray	None	Sand, clay	Unpolluted	40,000
1005	Oct. 21, 1909	Newark bay, 400 feet south of C. R.R. of N. J. bridge, 1000 feet off Elizabethport shore	40 39 14	74 09 58	9	0	Black	H_2S	Mud	Polluted	1,200,000
1006	Oct. 21, 1909	Newark bay, 400 feet south of C. R.R. of N. J. bridge, 1000 feet off Elizabethport shore	40 39 14	74 09 58	9	1	Black	H_2S	Mud, sand	Unpolluted	800,000
1007	Oct. 21, 1909	Newark bay, 400 feet south of C. R.R. of N. J. bridge, 1000 feet off Elizabethport shore	40 39 14	74 09 58	9	2	Gray	H_2S	Clay	Unpolluted	400,000
1008	Oct. 21, 1909	Newark bay, 400 feet south of C. R.R. of N. J. bridge, 1000 feet off Elizabethport shore	40 39 14	74 09 58	9	3	Gray	H_2S	Clay	Unpolluted	200,000
1009	Oct. 21, 1909	Newark bay, 400 feet south of C. R.R. of N. J. bridge, 1000 feet off Elizabethport shore	40 39 14	74 09 58	9	4	Gray	H_2S	Clay	Unpolluted	160,000
1010	Oct. 21, 1909	Newark bay, 400 feet south of C. R.R. of N. J. bridge, 1000 feet off Elizabethport shore	40 39 14	74 09 58	9	5	Gray	H_2S	Clay	Unpolluted	180,000
1011	Oct. 21, 1909	Newark bay, 400 feet south of C. R.R. of N. J. bridge, 1000 feet off Elizabethport shore	40 39 14	74 09 58	9	6	Gray	H_2S	Clay	Unpolluted	600,000
1012	Oct. 21, 1909	Newark bay, 400 feet south of C. R.R. of N. J. bridge, 1000 feet off Elizabethport shore	40 39 14	74 09 58	9	7	Gray	H_2S	Clay	Unpolluted	1,700,000
1013	Oct. 21, 1909	Newark bay, 400 feet south of C. R.R. of N. J. bridge, 1000 feet off Elizabethport shore	40 39 14	74 09 58	9	8	Gray	H_2S	Clay	Unpolluted	1,200,000
1014	Oct. 21, 1909	Newark bay, 400 feet south of C. R.R. of N. J. bridge, 1000 feet off Elizabethport shore	40 39 14	74 09 58	9	9	Gray	H_2S	Clay	Unpolluted	1,800,000
1015	Oct. 21, 1909	Newark bay, 400 feet south of C. R.R. of N. J. bridge, 1000 feet off Elizabethport shore	40 39 14	74 09 58	9	10	Gray	H_2S	Clay	Unpolluted	1,800,000

TABLE XIV—Continued

58—HUDSON RIVER

No.	Date of Collection	Location of Samples			Depth in feet		Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude	Water	Mud					
			° ′ ″	° ′ ″							
1016	Oct. 22, 1909	Hudson river, north side, Scandinavian line pier, Hoboken	40 45 17	74 01 22	30	0	Black	Coal tar	Mud	Polluted	9,000,000
1017	Oct. 22, 1909	Hudson river, north side, Scandinavian line pier, Hoboken	40 45 17	74 01 22	30	1	Black	Coal tar	Mud	Polluted	7,000,000
1018	Oct. 22, 1909	Hudson river, north side, Scandinavian line pier, Hoboken	40 45 17	74 01 22	30	2	Black	Coal tar	Mud	Polluted	6,000,000
1019	Oct. 22, 1909	Hudson river, north side, Scandinavian line pier, Hoboken	40 45 17	74 01 22	30	3	Black	Coal tar	Mud	Polluted	4,000,000
1020	Oct. 22, 1909	Hudson river, north side, Scandinavian line pier, Hoboken	40 45 17	74 01 22	30	4	Black	Coal tar	Mud	Polluted	2,000,000
1021	Oct. 22, 1909	Hudson river, north side, Scandinavian line pier, Hoboken	40 45 17	74 01 22	30	5	Black	Coal tar	Mud	Polluted	1,800,000
1022	Oct. 22, 1909	Hudson river, north side, Scandinavian line pier, Hoboken	40 45 17	74 01 22	30	6	Black	Coal tar	Mud	Polluted	4,000,000
1023	Oct. 22, 1909	Hudson river, north side, Scandinavian line pier, Hoboken	40 45 17	74 01 22	30	7	Black	Coal tar	Mud	Polluted	3,000,000
1024	Oct. 22, 1909	Hudson river, north side, Scandinavian line pier, Hoboken	40 45 17	74 01 22	30	8	Gray	Coal tar	Clay	Unpolluted	2,000,000
1025	Oct. 22, 1909	Hudson river, north side, Scandinavian line pier, Hoboken	40 45 17	74 01 22	30	9	Gray	Coal tar	Clay	Unpolluted	1,000,000
1026	Oct. 22, 1909	Hudson river, north side, Scandinavian line pier, Hoboken	40 45 17	74 01 22	30	10	Gray	Coal tar	Clay	Unpolluted	1,500,000
1027	Oct. 22, 1909	Hudson river, north side, Scandinavian line pier, Hoboken	40 45 17	74 01 22	30	11	Gray	Coal tar	Clay	Unpolluted	1,500,000

59—UPPER BAY

No.	Date of Collection	Location of Samples			Depth in feet		Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude	Water	Mud					
			° ′ ″	° ′ ″							
1028	Oct. 23, 1909	Upper bay, Red Hook channel, pier head line off Red Hook stores	40 40 43	74 01 13	30	0	Black	Sewage	Mud	Polluted	1,800,000
1029	Oct. 23, 1909	Upper bay, Red Hook channel, pier head line off Red Hook stores	40 40 43	74 01 13	30	1	Black	Sewage	Mud	Polluted	2,500,100
1030	Oct. 23, 1909	Upper bay, Red Hook channel, pier head line off Red Hook stores	40 40 43	74 01 13	30	2	Gray	None	Clay	Unpolluted	750,000
1031	Oct. 23, 1909	Upper bay, Red Hook channel, pier head line off Red Hook stores	40 40 43	74 01 13	30	3	Gray	None	Clay	Unpolluted	500,000

TABLE XIV—Continued

59—UPPER BAY—Continued

No.	Date of Collection	Location of Samples			Depth in feet		Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude	Water	Mud					
			° ′ ″	° ′ ″							
1032	Oct. 23, 1909	Upper bay, Red Hook channel, pier head line off Red Hook stores.............	40 40 43	74 01 13	30	4	Gray	None	Clay	Unpolluted	450,000
1033	Oct. 23, 1909	Upper bay, Red Hook channel, pier head line off Red Hook stores.............	40 40 43	74 01 13	30	5	Gray	None	Clay	Unpolluted	250,000
1034	Oct. 23, 1909	Upper bay, Red Hook channel, pier head line off Red Hook stores.............	40 40 43	74 01 13	30	6	Gray	None	Clay	Unpolluted	400,000
1035	Oct. 23, 1909	Upper bay, Red Hook channel, pier head line off Red Hook stores.............	40 40 43	74 01 13	30	7	Gray	None	Clay	Unpolluted	200,000

60—HUDSON RIVER

No.	Date of Collection	Location of Samples			Depth in feet		Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude	Water	Mud					
			° ′ ″	° ′ ″							
1036	Oct. 25, 1909	Hudson river, 200 feet off Jersey shore below ferry slip at Edgewater........	40 49 47	73 58 17	10	0	Gray	H_2S	Clay	Polluted	1,200,000
1037	Oct. 25, 1909	Hudson river, 200 feet off Jersey shore below ferry slip at Edgewater........	40 49 47	73 58 17	10	1	Gray	H_2S	Clay	Polluted	600,000
1038	Oct. 25, 1909	Hudson river, 200 feet off Jersey shore below ferry slip at Edgewater........	40 49 47	73 58 17	10	2	Gray	H_2S	Clay	Polluted	750,000
1039	Oct. 25, 1909	Hudson river, 200 feet off Jersey shore below ferry slip at Edgewater........	40 49 47	73 58 17	10	3	Gray	H_2S	Clay	Unpolluted	600,000
1040	Oct. 25, 1909	Hudson river, 200 feet off Jersey shore below ferry slip at Edgewater........	40 49 47	73 58 17	10	4	Gray	H_2S	Clay	Unpolluted	700,000
1041	Oct. 25, 1909	Hudson river, 200 feet off Jersey shore below ferry slip at Edgewater........	40 49 47	73 58 17	10	5	Gray	None	Clay	Unpolluted	350,000
1042	Oct. 25, 1909	Hudson river, 200 feet off Jersey shore below ferry slip at Edgewater........	40 49 47	73 58 17	10	6	Gray	None	Clay	Unpolluted	250,000
1043	Oct. 25, 1909	Hudson river, 200 feet off Jersey shore below ferry slip at Edgewater........	40 49 47	73 58 17	10	7	Gray	None	Clay	Unpolluted	300,000
1044	Oct. 25, 1909	Hudson river, 200 feet off Jersey shore below ferry slip at Edgewater........	40 49 47	73 58 17	10	8	Gray	None	Clay	Unpolluted	200,000

61—NEWARK BAY

No.	Date of Collection	Location of Samples			Depth in feet		Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude	Water	Mud					
			° ′ ″	° ′ ″							
1045	Nov. 3, 1909	Newark bay, 500 feet north of C. R.R. of N. J. bridge 2000 feet off the Elizabethport shore...............	40 39 23	74 09 45	6	0	Black	H_2S	Mud	Polluted	2,000,000
1046	Nov. 3, 1909	Newark bay, 500 feet north of C. R.R. of N. J. bridge 2000 feet off the Elizabethport shore...............	40 39 23	74 09 45	6	1	Black	H_2S	Mud	Polluted	1,800,000

TABLE XIV—Continued

61—NEWARK BAY—Continued

No.	Date of Collection	Location of Samples			Depth in feet		Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude	Water	Mud					
			° ′ ″	° ′ ″							
1047	Nov. 3, 1909	Newark bay, 500 feet north of C. R.R. of N. J. bridge 2000 feet off the Elizabethport shore	40 39 23	74 09 45	6	2	Black	H_2S	Mud, clay	Polluted	1,200,000
1048	Nov. 3, 1909	Newark bay, 500 feet north of C. R.R. of N. J. bridge 2000 feet off the Elizabethport shore	40 39 23	74 09 45	6	3	Gray	H_2S	Clay	Unpolluted	300,000
1049	Nov. 3, 1909	Newark bay, 500 feet north of C. R.R. of N. J. bridge 2000 feet off the Elizabethport shore	40 39 23	74 09 45	6	4	Gray	H_2S	Sand	Unpolluted	250,000
1050	Nov. 3, 1909	Newark bay, 500 feet north of C. R.R. of N. J. bridge 1000 feet off the Elizabethport shore	40 39 22	74 09 59	6	0	Black	H_2S	Mud	Polluted	4,000,000
1051	Nov. 3, 1909	Newark bay, 500 feet north of C. R.R. of N. J. bridge 1000 feet off the Elizabethport shore	40 39 22	74 09 59	6	1	Black	H_2S	Mud	Polluted	3,000,000
1052	Nov. 3, 1909	Newark bay, 500 feet north of C. R.R. of N. J. bridge 1000 feet off the Elizabethport shore	40 39 22	74 09 59	6	2	Gray	H_2S	Clay	Doubtful	1,200,000
1053	Nov. 3, 1909	Newark bay, 500 feet north of C. R.R. of N. J. bridge 1000 feet off the Elizabethport shore	40 39 22	74 09 59	6	3	Gray	H_2S	Clay	Unpolluted	650,000
1054	Nov. 3, 1909	Newark bay, 500 feet north of C. R.R. of N. J. bridge 1000 feet off the Elizabethport shore	40 39 22	74 09 59	6	4	Gray	None	Clay, sand	Unpolluted	400,000
1055	Nov. 3, 1909	Newark bay, 500 feet north of C. R.R. of N. J. bridge 1000 feet off the Elizabethport shore	40 39 22	74 09 59	6	5	Gray	None	Clay, sand	Unpolluted	200,000
1056	Nov. 3, 1909	Newark bay, 500 feet north of C. R.R. of N. J. bridge 1000 feet off the Elizabethport shore	40 39 22	74 09 59	6	6	Blue & gray	None	Clay	Unpolluted	250,000
1057	Nov. 3, 1909	Newark bay, 500 feet north of C. R.R. of N. J. bridge 1000 feet off the Elizabethport shore	40 39 22	74 09 59	6	7	Blue & gray	None	Clay	Unpolluted	120,000
1058	Nov. 3, 1909	Newark bay, 1000 feet north of C. R.R. of N. J. bridge 1000 feet off Centerville	40 39 27	74 08 20	6	0	Black	Sewage	Sand	Polluted	3,000,000
1059	Nov. 3, 1909	Newark bay, 1000 feet north of C. R.R. of N. J. bridge 1000 feet off Centerville	40 39 27	74 08 20	6	1	Gray	None	Clay and sand	Polluted	250,000
1060	Nov. 3, 1909	Newark bay, 1000 feet north of C. R.R. of N. J. bridge 1000 feet off Centerville	40 39 27	74 08 20	6	2	Gray	None	Clay and sand	Unpolluted	50,000
1061	Nov. 3, 1909	Newark bay, 1000 feet north of C. R.R. of N. J. bridge 1000 feet off Centerville	40 39 27	74 08 20	6	3	Gray	None	Clay and sand	Unpolluted	125,000

TABLE XIV—Continued

61—NEWARK BAY—Continued

No.	Date of Collection	Location of Samples			Depth in feet		Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude	Water	Mud					
			° ′ ″	° ′ ″							
1062	Nov. 3, 1909	Newark bay, 1000 feet north of C. R.R. of N. J. bridge 1000 feet off Centerville. .	40 39 27	74 08 20	6	4	Gray	None	Clay and sand	Unpolluted	60,000
1063	Nov. 3, 1909	Newark bay, 1000 feet north of C. R.R. of N. J. bridge 1000 feet off Centerville. .	40 39 27	74 08 20	6	5	Gray	None	Clay	Unpolluted	50,000
1064	Nov. 3, 1909	Newark bay, 1000 feet north of C. R.R. of N. J. bridge 1000 feet off Centerville. .	40 39 27	74 08 20	6	6	Gray	None	Clay	Unpolluted	40,000
1065	Nov. 3, 1909	Newark bay, 1000 feet north of C. R.R. of N. J. bridge 1000 feet off Centerville. .	40 39 27	74 08 20	6	7	Gray	None	Clay	Unpolluted	20,000
1066	Nov. 3, 1909	Newark bay, ½ mile southeast of red buoy No. 4, 2000 feet south of L. V. R.R. trestle.	40 41 25	74 06 52	8	0	Gray	H_2S	Clay	Polluted	2,000,000
1067	Nov. 3, 1909	Newark bay, ½ mile southeast of red buoy No. 4, 2000 feet south of L. V. R. R. trestle.	40 41 25	74 06 52	8	1	Gray	H_2S	Clay	Doubtful	1,000,000
1068	Nov. 3, 1909	Newark bay, ½ mile southeast of red buoy No. 4, 2000 feet south of L. V. R. R. trestle.	40 41 25	74 06 52	8	2	Gray	H_2S	Clay	Unpolluted	350,000
1069	Nov. 3, 1909	Newark bay, ½ mile southeast of red buoy No. 4, 2000 feet south of L. V. R.R. trestle.	40 41 25	74 06 52	8	3	Gray	H_2S	Clay	Unpolluted	250,000
1070	Nov. 3, 1909	Newark bay, ½ mile southeast of red buoy No. 4, 2000 feet south of L. V. R.R. trestle.	40 41 25	74 06 52	8	4	Gray	H_2S	Clay	Unpolluted	350,000
1071	Nov. 3, 1909	Newark bay, ½ mile southeast of red buoy No. 4, 2000 feet south of L. V. R.R. trestle.	40 41 25	74 06 52	8	5	Gray	H_2S	Clay	Unpolluted	80,000
1072	Nov. 3, 1909	Newark bay, ½ mile southeast of red buoy No. 4, 2000 feet south of L. V. R.R. trestle.	40 41 25	74 06 52	8	6	Gray	H_2S	Clay	Unpolluted	60,000

62—HUDSON RIVER

No.	Date of Collection	Location of Samples			Depth in feet		Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude	Water	Mud					
			° ′ ″	° ′ ″							
1073	Nov. 4, 1909	Hudson river, opposite Ft. Washington Point, 500 feet off the New Jersey shore.	40 51 06	73 57 32	12	0	Black	Sewage	Mud	Polluted	1,800,000
1074	Nov. 4, 1909	Hudson river, opposite Ft. Washington Point, 500 feet off the New Jersey shore.	40 51 06	73 57 32	12	1	Gray	H_2S	Clay	Unpolluted	1,000,000

TABLE XIV—Continued

62—HUDSON RIVER—Continued

No.	Date of Collection	Location of Samples			Depth in feet		Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude	Water	Mud					
			° ′ ″	° ′ ″							
1075	Nov. 4, 1909	Hudson river, opposite Ft. Washington Point, 500 feet off the New Jersey shore..................	40 51 06	73 57 32	12	2	Gray	H_2S	Clay	Unpolluted	850,000
1076	Nov. 4, 1909	Hudson river, opposite Ft. Washington Point, 500 feet off the New Jersey shore..................	40 51 06	73 57 32	12	3	Gray	H_2S	Clay	Unpolluted	700,000
1077	Nov. 4, 1909	Hudson river, opposite Ft. Washington Point, 500 feet off the New Jersey shore..................	40 51 06	73 57 32	12	4	Gray	H_2S	Clay	Unpolluted	250,000
1078	Nov. 4, 1909	Hudson river, opposite Ft. Washington Point, 500 feet off the New Jersey shore..................	40 51 06	73 57 32	12	5	Gray	H_2S	Clay	Unpolluted	100,000
1079	Nov. 4, 1909	Hudson river, opposite Ft. Washington Point, 500 feet off the New Jersey shore..................	40 51 06	73 57 32	12	6	Gray	H_2S	Clay	Unpolluted	120,000
1080	Nov. 4, 1909	Hudson river, opposite Ft. Washington Point, 500 feet off the New Jersey shore..................	40 51 06	73 57 32	12	7	Gray	H_2S	Clay	Unpolluted	250,000
1081	Nov. 4, 1909	Hudson river, opposite Ft. Washington Point, 500 feet off the New Jersey shore..................	40 51 06	73 57 32	12	8	Gray	None	Clay	Unpolluted	100,000
1082	Nov. 4, 1909	Hudson river, opposite Ft. Washington Point, 500 feet off the New Jersey shore..................	40 51 06	73 57 32	12	9	Gray	None	Clay	Unpolluted	12,000
1083	Nov. 4, 1909	Hudson river, opposite Ft. Washington Point, 500 feet off the New Jersey shore..................	40 51 06	73 57 32	12	10	Gray	None	Clay	Unpolluted	16,000
1084	Nov. 6, 1909	Hudson river, opposite W. 157th street, Manhattan, 500 feet off the New Jersey shore..................	40 50 31	73 57 54	16	0	Black	Sewage	Mud	Polluted	1,800,000
1085	Nov. 6, 1909	Hudson river, opposite W. 157th street, Manhattan, 500 feet off the New Jersey shore..................	40 50 31	73 57 54	16	1	Black	H_2S	Mud and clay	Polluted	1,200,000
1086	Nov. 6, 1909	Hudson river, opposite W. 157th street, Manhattan, 500 feet off the New Jersey shore..................	40 50 31	73 57 54	16	2	Gray	H_2S	Clay	Polluted	500,000
1087	Nov. 6, 1909	Hudson river, opposite W. 157th street, Manhattan, 500 feet off the New Jersey shore..................	40 50 31	73 57 54	16	3	Gray	H_2S	Clay	Polluted	500,000
1088	Nov. 6, 1909	Hudson river, opposite W. 157th street, Manhattan, 500 feet off the New Jersey shore..................	40 50 31	73 57 54	16	4	Gray	H_2S	Clay	Polluted	250,000
1089	Nov. 6, 1909	Hudson river, opposite W. 157th street, Manhattan, 500 feet off the New Jersey shore..................	40 50 31	73 57 54	16	5	Gray	H_2S	Clay	Unpolluted	400,000

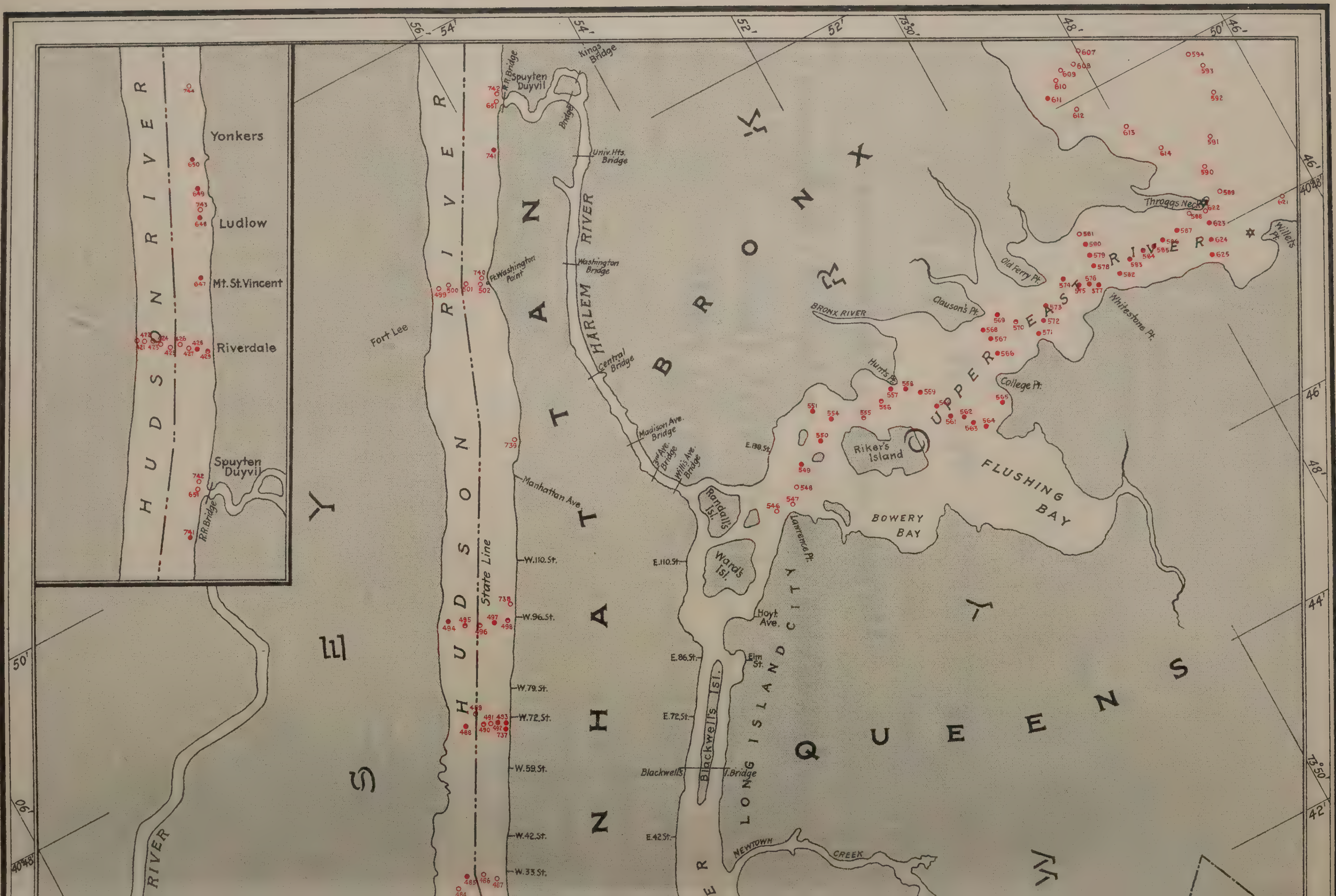
TABLE XIV—Continued

62—HUDSON RIVER—Continued

No.	Date of Collection	Location of Samples			Depth in feet		Color	Odor	Consistency	Opinion	Bacteria per gram
		Approximate	Latitude	Longitude	Water	Mud					
			° ′ ″	° ′ ″							
1090	Nov. 6, 1909	Hudson river, opposite W. 157th street, Manhattan, 500 feet off the New Jersey shore	40 50 31	73 57 54	16	6	Gray	None	Clay	Unpolluted	120,000
1091	Nov. 6, 1909	Hudson river, opposite W. 157th street, Manhattan, 500 feet off the New Jersey shore	40 50 31	73 57 54	16	7	Gray	None	Clay	Unpolluted	50,000
1092	Nov. 6, 1909	Hudson river, opposite W. 59th street, Manhattan, 500 feet off the New Jersey shore	40 46 40	74 00 20	35	0	Black.	H_2S	Mud	Polluted	2,400,000
1093	Nov. 6, 1909	Hudson river, opposite W. 59th street, Manhattan, 500 feet off the New Jersey shore	40 46 40	74 00 20	35	1	Black	H_2S	Mud	Polluted	2,000,000
1094	Nov. 6, 1909	Hudson river, opposite W. 59th street, Manhattan, 500 feet off the New Jersey shore	40 46 40	74 00 20	35	2	Black	H_2S	Mud	Polluted	1,800,000
1095	Nov. 6, 1909	Hudson river, opposite W. 59th street, Manhattan, 500 feet off the New Jersey shore	40 46 40	74 00 20	35	3	Gray	H_2S	Clay	Polluted	800,000
1096	Nov. 6, 1909	Hudson river, opposite W. 59th street, Manhattan, 500 feet off the New Jersey shore	40 46 40	74 00 20	35	4	Gray	H_2S	Clay	Polluted	600,000
1097	Nov. 6, 1909	Hudson river, opposite W. 59th street, Manhattan, 500 feet off the New Jersey shore	40 46 40	74 00 20	35	5	Gray	None	Clay	Unpolluted	400,000
1098	Nov. 6, 1909	Hudson river, opposite W. 59th street, Manhattan, 500 feet off the New Jersey shore	40 46 40	74 00 20	35	6	Gray	None	Clay	Unpolluted	60,000
1099	Nov. 6, 1909	Hudson river, opposite W. 59th street, Manhattan, 500 feet off the New Jersey shore	40 46 40	74 00 20	35	7	Gray	None	Clay	Unpolluted	40,000
1100	Nov. 6, 1909	Hudson river, opposite W. 59th street, Manhattan, 500 feet off the New Jersey shore	40 46 40	74 00 20	35	8	Gray	None	Clay	Unpolluted	20,000

Plate A

Microscopic Examinations of Dredgings from the Surface of the Bottom of New York Harbor in 1908 and 1909


HUDSON RIVER
Yonkers
Ludlow
Mt. St. Vincent
Riverdale
Spuyten Duyvil
R.R. Bridge
744
650
649
743
648
647
421
422
423
424
425
426
427
428
429
742
651
741
HUDSON RIVER
State Line
Fort Lee
Ft. Washington Point
Kings Bridge
Bridge
Univ. Hts. Bridge
Washington Bridge
HARLEM RIVER
Central Bridge
Madison Ave. Bridge
3rd Ave. Bridge
Willis Ave. Bridge
Manhattan Ave.
W. 110 St.
W. 96 St.
W. 79 St.
W. 72 St.
W. 59 St.
W. 42 St.
W. 33 St.
E. 138 St.
E. 110 St.
E. 86 St.
E. 72 St.
E. 42 St.
Blackwell's I. Bridge
Blackwell's Isl.
Randall's Isl.
Ward's Isl.
Hoyt Ave.
Elm St.
LONG ISLAND CITY
NEWTOWN CREEK
Lawrence Pt.
BOWERY BAY
FLUSHING BAY
Riker's Island
UPPER EAST RIVER
College Pt.
Hunts Pt.
BRONX RIVER
Clauson's Pt.
Old Ferry Pt.
Whitestone Pt.
Throggs Neck
Willets Pt.
BRONX
MANHATTAN
QUEENS
NEW JERSEY
740
499
500
501
502
739
738
494
495
496
497
498
488
489
490
491
492
493
737
484
485
486
487
546
547
548
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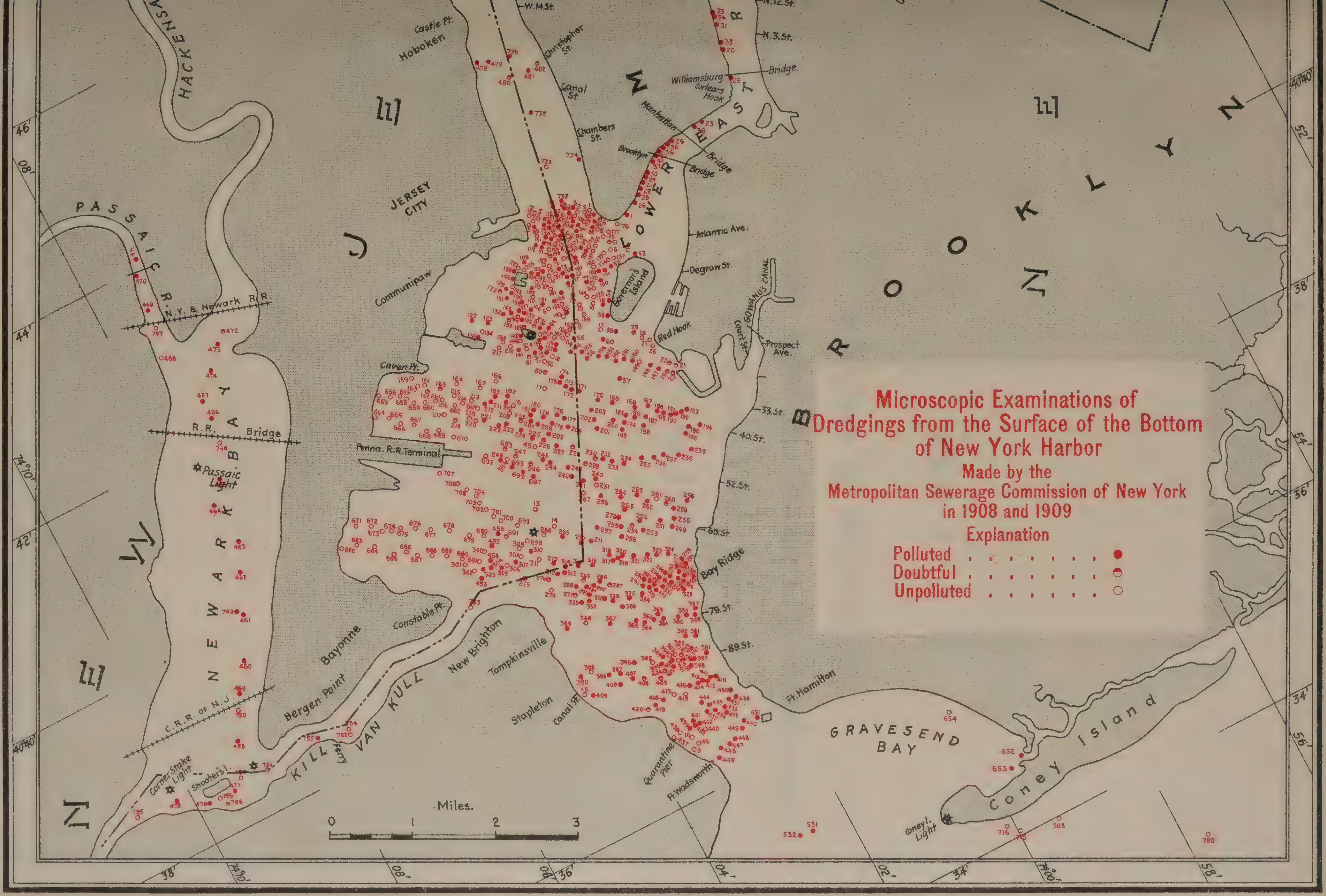
623
624
625
56'
54'
52'
50'
48'
46'
44'
42'
73°50'
40°48'
06'

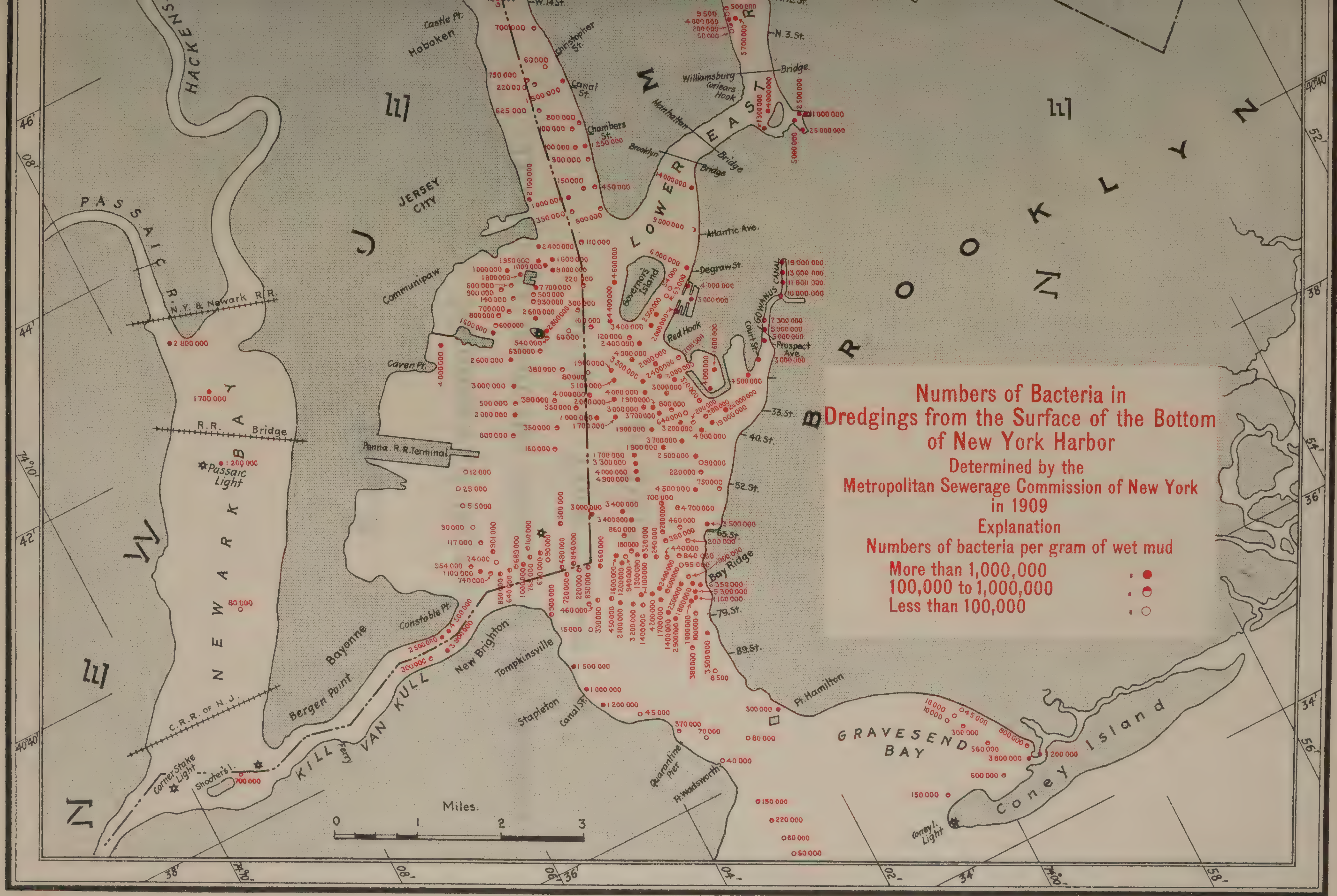


A

Plotted from Data Contained in Table XIV, pp. 176–207. Small Figures are Examination Numbers as given in 1st Column of Table XIV. Other Microscopic Examinations of Material from the Surface of the Harbor Bottom are shown on Plate C.

Plate B

Numbers of Bacteria in
Dredgings from the Surface of the Bottom
of New York Harbor
in 1909



B

Plotted from Data Contained in Table XIV, pp. 184–206. Other Determinations of Numbers of Bacteria in Material from the Surface of the Harbor Bottom are shown on Plate C.

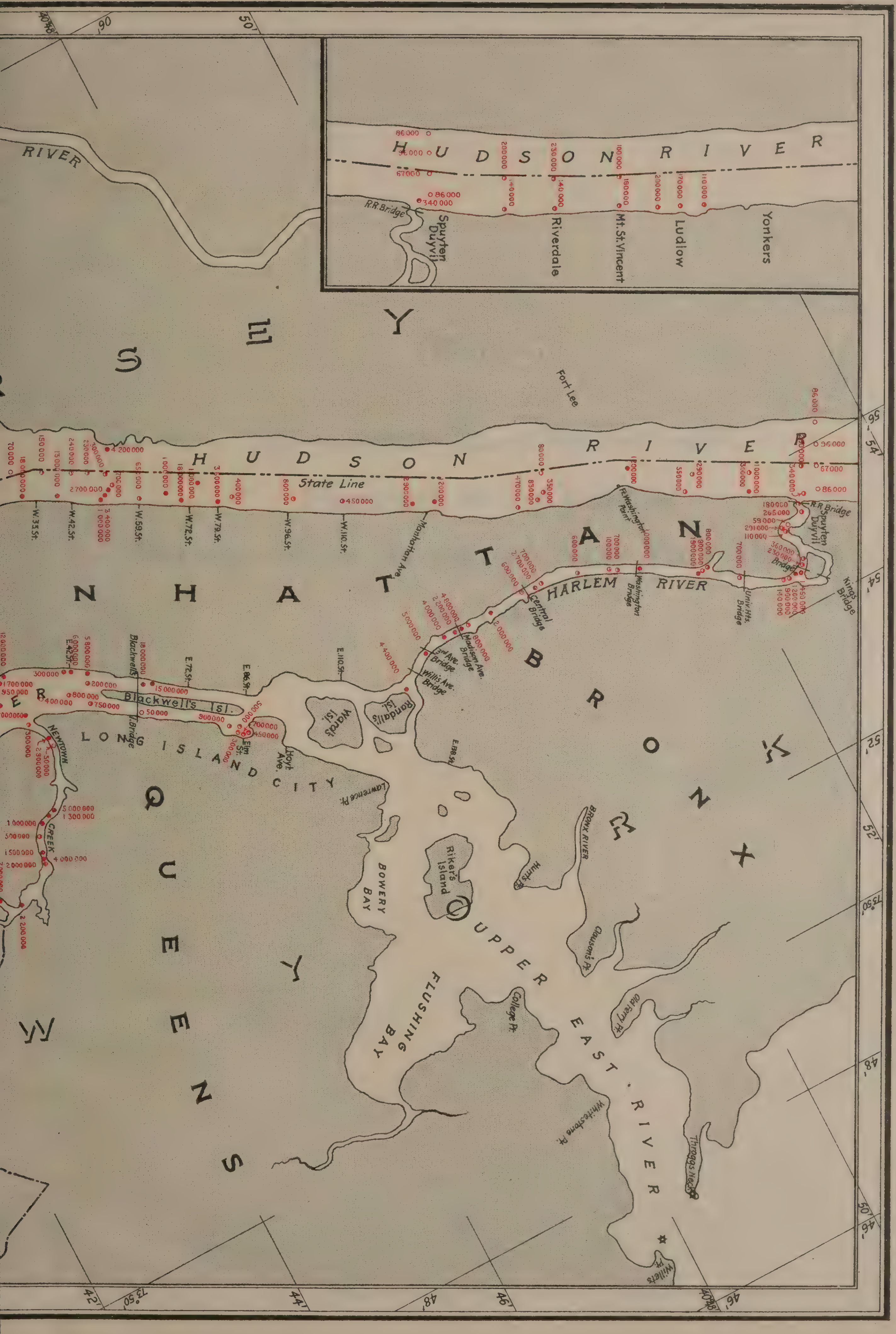
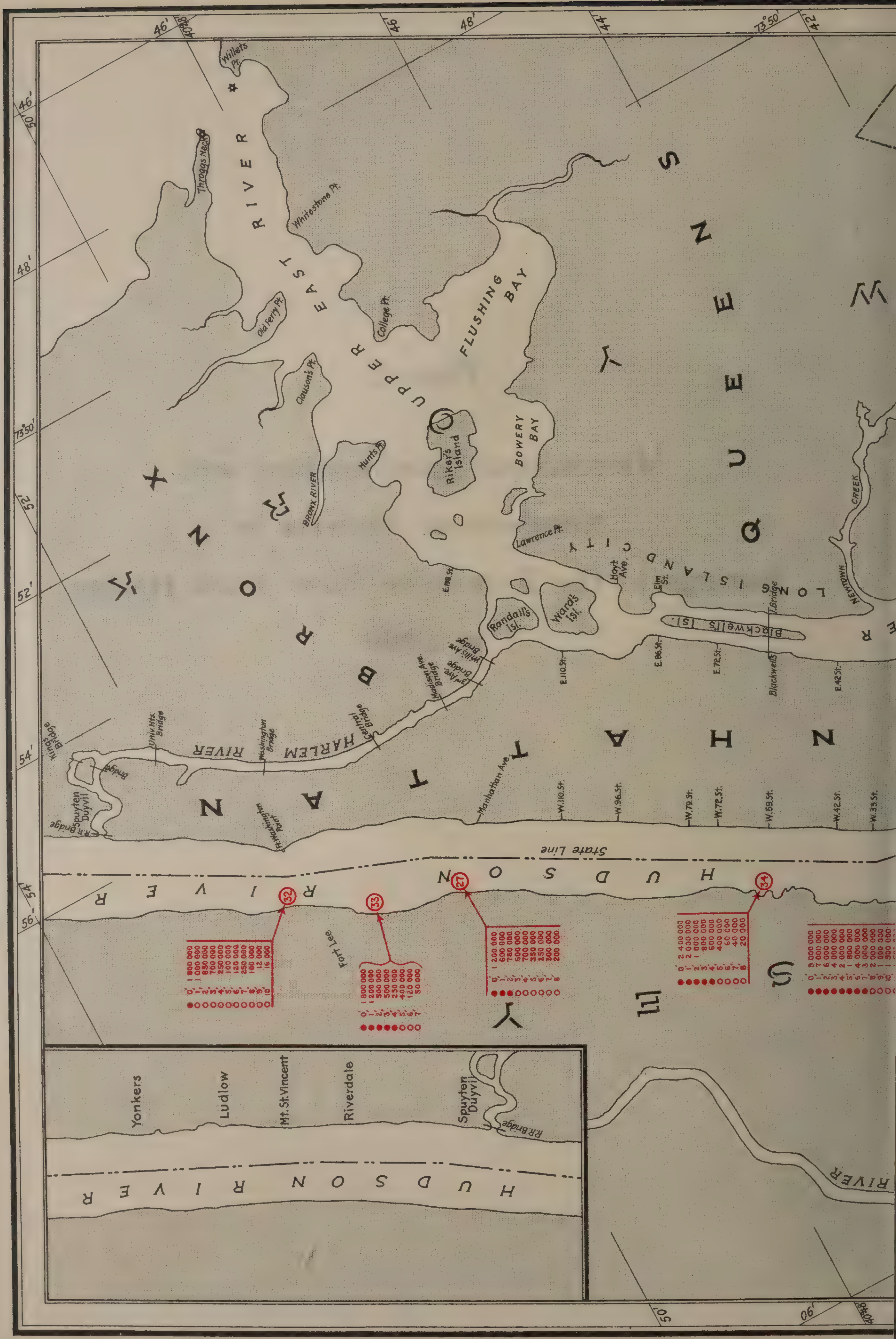
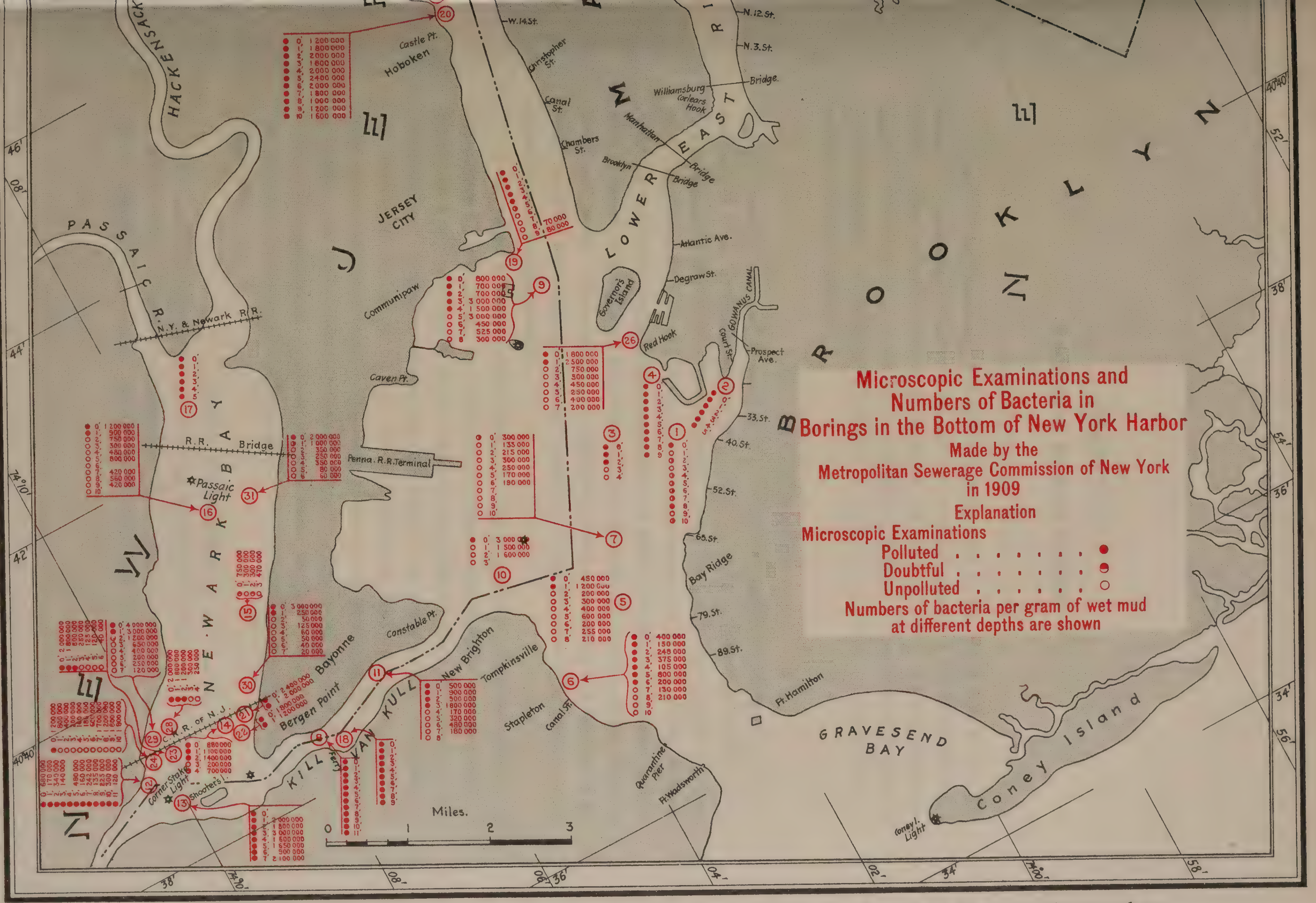

HUDSON RIVER
Spuyten Duyvil
R.R. Bridge
Riverdale
Mt. St. Vincent
Ludlow
Yonkers
86 000
340 000
67 000
RIVER
JERSEY
Fort Lee
HUDSON RIVER
State Line
W. 33 St.
W. 42 St.
W. 59 St.
W. 72 St.
W. 79 St.
W. 96 St.
W. 110 St.
Manhattan Ave.
Ft. Washington Point
MANHATTAN
HARLEM RIVER
Central Bridge
Washington Bridge
Univ. Hts. Bridge
Kings Bridge
Madison Ave. Bridge
3rd Ave. Bridge
Willis Ave. Bridge
E. 42 St.
E. 72 St.
E. 86 St.
E. 110 St.
E. 138 St.
Blackwell's
Blackwell's Isl.
Ward's Isl.
Randall's Isl.
LONG ISLAND CITY
Elm St.
Hoyt Ave.
NEWTOWN CREEK
Lawrence Pt.
BRONX
BRONX RIVER
Hunts Pt.
Riker's Island
BOWERY BAY
FLUSHING BAY
UPPER EAST RIVER
College Pt.
Clawson's Pt.
Old Ferry Pt.
Whitestone Pt.
Throggs Neck
Willets Pt.
QUEENS
NEW YORK
40°48'
50'
54'
56'
52'
73°50'
48'
46'
44'
42'
4 200 000
2 700 000
450 000
15 000 000
200 000
800 000
750 000
50 000
400 000
300 000
1 700 000
950 000
5 000 000
1 300 000
4 000 000
2 200 000
2 000 000
4 400 000
5 800 000
18 000 000

Plate C

Microscopic Examinations and Numbers of Bacteria in Borings in the Bottom of New York Harbor in 1909


BRONX
MANHATTAN
QUEENS
NEW JERSEY
UPPER EAST RIVER
FLUSHING BAY
BOWERY BAY
HARLEM RIVER
HUDSON RIVER
BRONX RIVER
NEWTOWN CREEK
LONG ISLAND CITY
State Line
Willets Pt.
Throggs Neck
Whitestone Pt.
Old Ferry Pt.
College Pt.
Clausons Pt.
Hunts Pt.
Riker's Island
Lawrence Pt.
Randall's Isl.
Ward's Isl.
Blackwell's Isl.
Hoyt Ave.
Elm St.
E.138 St.
E.110 St.
E.86 St.
E.72 St.
E.42 St.
Blackwell's I. Bridge
Willis Ave. Bridge
3rd Ave. Bridge
Madison Ave. Bridge
Central Bridge
Washington Bridge
Univ. Hts. Bridge
Kings Bridge
Bridge
Spuyten Duyvil
R.R. Bridge
Ft. Washington Point
Manhattan Ave.
W.110 St.
W.96 St.
W.79 St.
W.72 St.
W.59 St.
W.42 St.
W.33 St.
Fort Lee
RIVER
Yonkers
Ludlow
Mt. St. Vincent
Riverdale
46'
40°48'
45'
48'
44'
73°50'
42'
50'
52'
54'
56'
06'
40°45'
32
0 1 800 000
1 1 000 000
2 850 000
3 700 000
4 250 000
5 100 000
6 120 000
7 250 000
8 100 000
9 12 000
10 16 000
33
0 1 800 000
1 1 200 000
2 500 000
3 500 000
4 250 000
5 400 000
6 120 000
7 50 000
27
0 1 200 000
1 600 000
2 780 000
3 600 000
4 700 000
5 350 000
6 250 000
7 300 000
8 200 000
34
0 2 400 000
1 2 000 000
2 1 800 000
3 800 000
4 500 000
5 400 000
6 60 000
7 40 000
8 20 000
0 9 000 000
1 7 000 000
2 6 000 000
3 4 000 000
4 2 000 000
5 1 800 000
6 4 000 000
7 3 000 000
8 2 000 000
9 1 000 000
10 1 500 000



C

Plotted from data Contained in Table XIV, pp. 207–222. Numbers in Circles from 1 to 34 are boring numbers, and correspond to Sample Nos. 821 to 1100.

CHAPTER II

BACTERIA IN THE WATER

INTRODUCTION TO TABLE XV

The object in determining the numbers of bacteria in the water was to gain information concerning the relative intensity of sewage pollution at various points in the harbor, chiefly with the idea of determining the rate at which the sewage disappeared. The work done by the New York Bay Pollution Commission had given a favorable opinion of the value of numbers of bacteria as an index of the intensity of pollution of these waters.

Sampling and Controls

The samples were taken according to a carefully predetermined plan and were designed to cover, as thoroughly as practicable, the large range of conditions which it was necessary to observe. The work was controlled by taking samples of water from unpolluted harbors and from various points where the extent of the pollution could be ascertained by methods independent of these analyses. Duplicate samples were collected and analyzed from time to time in order to obtain a check upon the laboratory work. The samples were collected, plated and counted and the rest of the technical detail performed by Payn B. Parsons, A. M., M. D., under the direction of the President of the Commission.

It was usual to collect samples from the surface and at two or more depths below the surface at each point. In each case the observer was aware of the total depth of water and was careful not to disturb deposits upon the bottom when deep samples were collected. In taking samples near the surface, care was exercised to avoid material floating on or close to the top. The very surface of the water was often covered with grease, soot and floating débris, some of which were apparently of sewage origin and some from docks, piers, streets and shipping. The water for analysis was collected with the intention of getting samples which would be fairly representative of the average condition of the whole mass of water present at the time and place of observation.

Method of Analysis

The number of bacteria in the water was determined by the method recommended by the Committee on Standard Methods of Water Analysis of the American Public Health Association and is in general use in the water laboratories of the United

States. Considerable advantage was thought to be gained by plating at the time the sample was collected. The samples were collected from a boat by means of sterilized vacuum tubes. The tubes were enclosed in heavy casings, lowered to the proper depth and the seal broken, whereupon the water flowed in.

The culture medium was made up of 10 per cent. gelatin and beef extract. The reaction was carefully adjusted to 1.0 acid to phenolphthalein. When there was reason to believe that the numbers would be excessive, the sample was diluted with distilled water and 1 c.c. of this dilution mixed with the culture medium.

The bacteria were incubated at 70 degrees Fahrenheit for 48 hours and then counted. The results were stated as numbers of bacteria per cubic centimeter of the water.

Location of Samples

At the time the sample was collected, the location of the boat was determined by means of a sextant or prismatic compass with which readings were taken to prominent landmarks or by estimating the distance to nearby points. The depth from which the sample was taken was noted, as was the temperature of the water, the salinity of the water and the direction of the tidal current. Subsequently, the time of extreme high and low tide at the nearest official gaging station was obtained from United States Government recording tide gages. The force and direction of the wind were ascertained from the official records of the United States Weather Bureau.

The location of the point from which a sample was taken was plotted upon a standard chart issued by the United States Coast and Geodetic Survey, scale 1/40,000, using for this purpose the bearings or distances noted from the boat to prominent landmarks. From these charts the latitude and longitude were derived. Plate D gives the number of bacteria in the water at each location.

TABLE XV

NUMBER OF BACTERIA IN THE WATER IN THE YEAR 1909

Table of Contents

Section No.	Location	Date of Collection	Page
1	Upper bay	March 23, 1909	226
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3	Upper bay	April 7, 1909	226
4	Long Island Sound	April 13, 1909	227
5	Long Island Sound	April 15, 1909	228
6	The Narrows	April 19, 1909	228
7	East river	April 22, 1909	229
8	Kill van Kull	April 26, 1909	230
9	Harlem river	April 27, 1909	231
10	Hudson river	May 3, 1909	232
11	Hudson river	May 4, 1909	233
12	Newark bay and Passaic river	May 10, 1909	234
13	Hudson river	May 11, 1909	236
14	Hudson river	May 12, 1909	236
15	Upper bay, Lower bay and Atlantic ocean	May 13, 1909	236
16	Lower bay	May 17, 1909	238
17	Lower bay	May 18, 1909	238
18	Lower bay	May 19, 1909	240
19	East river	May 26, 1909	241
20	Harlem river	May 26, 1909	242
21	Rockaway inlet	June 29 and July 1, 1909	242
22	Jamaica bay	June 29, 1909	243
23	Jamaica bay	June 30, 1909	243
24	Jamaica bay	July 1, 1909	243
25	Hudson river	July 7, 1909	244
26	Gravesend bay and Coney Island creek	July 9, 1909	244
27	Gravesend bay	July 10, 1909	244
28	Sandy Hook bay, Shrewsbury river and Lower bay	July 13, 1909	245
29	Lower bay	July 13, 1909	245
30	Lower bay	July 14, 1909	245
31	Harlem river	July 15, 1909	245
32	Upper bay	July 16, 1909	246
33	The Narrows	July 16, 1909	246
34	Upper bay	July 16, 1909	246
35	Kill van Kull	July 17, 1909	246
36	Upper bay	July 17, 1909	246
37	Upper bay, Narrows and Lower bay	July 20, 1909	247
38	Lower bay	July 21, 1909	247
39	Atlantic ocean	July 21, 1909	247
40	Lower bay	July 21, 1909	247
41	The Narrows	July 21, 1909	247
42	Upper bay	July 21, 1909	247
43	Hudson river, Upper and Lower bay	July 22, 1909	248
44	East river	July 24, 1909	248
45	Hudson river	July 26, 1909	249
46	Hudson river	Aug. 19, 1909	249
47	Hudson river	Sept. 7, 1909	249
48	Passaic river, Newark bay and Kill van Kull	Sept. 8, 1909	250
49	East river	Sept. 9, 1909	250
50	Long Island Sound	Sept. 9, 1909	251
51	East river	Sept. 10, 1909	251
52	Kill van Kull	Sept. 11, 1909	252
53	Lower bay	Sept. 13, 1909	252
54	Lower bay	Sept. 14, 1909	253
55	Passaic river, Newark bay and Kill van Kull	Sept. 15, 1909	253
56	Arthur Kill	Sept. 16, 1909	254
57	Jamaica bay	Sept. 17, 1909	255
58	Hudson river	Sept. 18, 1909	255
59	Lower bay	Sept. 20, 1909	255
60	Raritan bay	Sept. 21, 1909	256
61	Arthur Kill	Sept. 21, 1909	256
62	Kill van Kull, Upper bay and East river	Sept. 23, 1909	257
63	Upper bay	Sept. 30, 1909	257
64	Kill van Kull	Sept. 30, 1909	257
65	East river	Oct. 1, 1909	258
66	Long Island Sound	Oct. 1, 1909	258
67	East river	Oct. 1, 1909	258
68	Harlem river	Oct. 1, 1909	258
69	East river	Oct. 1, 1909	258
70	Hudson river	Oct. 5, 1909	259

TABLE XV

Number of Bacteria in the Water in the Year 1909

1—UPPER BAY. MARCH 23, 1909

High water occurred at Governor's Island at 9.41 a. m. The wind was northwest with a velocity of 35 miles per hour.

Sample No.	Hour A. M.	Location of Samples: Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
			° ′ ″	° ′ ″					
1	11.40	About 2000 feet from Constable Hook.....	40 39 07	74 04 53	1	Ebb	3.0	—	3,180
2	11.50	About 2000 feet from Constable Hook.....	40 39 07	74 04 53	10	Ebb	3.0	—	6,360
3	1.00	Farther east than sample 1...............	40 39 03	74 04 20	1	Ebb	3.0	—	25,400
4	1.10	Farther east than sample 1...............	40 39 03	74 04 20	10	Ebb	3.0	—	19,100
5	1.35	Farther east than sample 3...............	40 39 06	74 04 38	1	Ebb	3.0	—	15,900
6	1.45	Farther east than sample 3...............	40 39 06	74 04 38	20	Ebb	3.4	—	12,700
7	2.15	About 20 feet from spar buoy A..........	40 38 41	74 03 49	1	Ebb	3.0	—	28,600
8	2.25	About 20 feet from spar buoy A..........	40 38 41	74 03 49	20	Ebb	3.2	—	14,100
9	2.50	About 600 feet off 71st street, Brooklyn...	40 38 25	74 02 10	1	Ebb	3.0	—	38,100
10	3.00	About 600 feet off 71st street, Brooklyn...	40 38 25	74 02 10	20	Ebb	3.2	—	26,500
11	3.35	About 200 feet farther out than sample 9..	40 38 30	74 02 22	1	Ebb	3.2	—	36,900
12	3.40	About 200 feet farther out than sample 9..	40 38 30	74 02 22	20	Ebb	3.4	—	21,600

2—UPPER BAY. MARCH 24, 1909

High water occurred at Governor's Island at 10.46 p. m. The wind was east with a velocity of 5 miles per hour at 10.30 a. m., increasing to 20 miles per hour at 2.00 p. m.

13	10.30	About 200 feet east of spar buoy A........	40 38 39	74 03 43	1	Flood	2.8	—	12,700
14	10.40	About 200 feet east of spar buoy A........	40 38 39	74 03 43	20	Flood	3.0	—	25,300
15	11.00	Farther east than sample 13..............	40 38 35	74 02 43	1	Flood	2.8	—	19,100
16	11.05	Farther east than sample 13..............	40 38 35	74 02 43	20	Flood	2.8	—	15,300
17	11.25	Farther east than sample 15..............	40 38 33	74 03 25	1	Flood	2.8	—	8,000
18	11.30	Farther east than sample 15..............	40 38 33	74 03 25	20	Flood	2.6	—	6,700
19	11.45	Farther east than sample 17..............	40 38 32	74 03 10	1	Flood	2.8	—	12,700
20	11.50	Farther east than sample 17..............	40 38 32	74 03 10	20	Flood	2.8	—	9,200
21	12.00	200 feet north of spar buoy 12½.........	40 38 23	74 03 18	1	Flood	3.0	—	14,000
22	12.05	200 feet north of spar buoy 12½.........	40 38 23	74 03 18	20	Flood	3.2	—	8,700
23	12.50	200 feet north of spar buoy 12½.........	40 38 23	74 03 18	1	Ebb	3.0	—	33,700
24	12.55	200 feet north of spar buoy 12½.........	40 38 23	74 03 18	20	Ebb	3.2	—	14,000
25	1.30	Farther east than sample 21..............	40 38 18	74 02 43	1	Ebb	3.0	—	28,000
26	1.35	Farther east than sample 21..............	40 38 18	74 02 43	20	Ebb	3.2	—	16,500
27	2.15	Farther east than sample 25..............	40 38 35	74 02 43	1	Ebb	3.0	—	19,100
28	2.20	Farther east than sample 25..............	40 38 35	74 02 43	20	Ebb	3.2	—	21,600
29	2.40	Farther east than sample 27..............	40 38 33	74 02 33	1	Ebb	3.2	—	31,800
30	2.45	Farther east than sample 27..............	40 38 33	74 02 33	20	Ebb	3.4	—	22,900
31	3.10	Farther east than sample 29..............	40 38 22	74 02 25	1	Ebb	3.0	—	33,100
32	3.15	Farther east than sample 29..............	40 38 22	74 02 25	20	Ebb	3.2	—	19,100
33	3.40	800 feet off 71st street, Brooklyn..........	40 38 19	74 02 15	1	Ebb	3.0	—	39,400
34	3.45	800 feet off 71st street, Brooklyn..........	40 38 19	74 02 15	20	Ebb	3.2	—	26,700

3—UPPER BAY. APRIL 7, 1909

Low water occurred at Governor's Island at 3.25 P. M. The wind was southwest with a velocity of 5 miles per hour

35	12.50	Liberty Island boat pier at Battery Park..	40 42 05	74 01 00	Surface	Ebb	—	—	6,400
36	12.52	Liberty Island boat pier at Battery Park..	40 42 05	74 01 00	½	Ebb	—	—	5,300
37	12.54	Liberty Island boat pier at Battery Park..	40 42 05	74 01 00	1	Ebb	—	—	5,200
38	12.56	Liberty Island boat pier at Battery Park..	40 42 05	74 01 00	2	Ebb	—	—	4,600

TABLE XV—Continued

3—UPPER BAY. APRIL 7, 1909—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
		Approximate	Latitude	Longitude					
			° ' "	° ' "					
39	1.20	Pier at east end of Liberty Island.........	40 41 21	74 02 35	Surface	Ebb	—	—	5,300
40	1.22	Pier at east end of Liberty Island.........	40 41 21	74 02 35	½	Ebb	—	—	5,200
41	1.24	Pier at east end of Liberty Island.........	40 41 21	74 02 35	1	Ebb	—	—	2,600
42	1.26	Pier at east end of Liberty Island.........	40 41 21	74 02 35	2	Ebb	—	—	2,100
43	3.20	End of pier A, Hudson river.............	40 42 16	74 01 08	Surface	Ebb	—	—	10,500
44	3.22	End of pier A, Hudson river.............	40 42 16	74 01 08	½	Ebb	—	—	9,500
45	3.24	End of pier A, Hudson river.............	40 42 16	74 01 08	1	Ebb	—	—	6,400
46	3.26	End of pier A, Hudson river.............	40 42 16	74 01 08	2	Ebb	—	—	4,200

4—LONG ISLAND SOUND. APRIL 13, 1909.

High water occurred at Governor's Island at 1.56 P. M. The wind was south with a velocity of 15 miles per hour until 9.00 A. M. From 9.00 A. M. the wind was southwest with a velocity from 30 to 50 miles per hour.

47	5.00	Greenport Harbor buoy No. 3...........	41 06 00	72 21 05	1	Ebb	—	10	440
48	5.00	Greenport Harbor buoy No. 3...........	41 06 00	72 21 05	20	Ebb	—	10	120
49	6.00	Gardiners bay just inside Orient Point.....	41 09 00	72 12 30	1	Ebb	—	10	240
50	6.00	Gardiners bay just inside Orient Point.....	41 09 00	72 12 30	20	Ebb	—	10	96
51	7.00	In Long Island Sound 1000 feet off Mulfords Point..........................	41 10 00	71 17 05	1	Ebb	—	10	120
52	7.00	In Long Island Sound 1000 feet off Mulfords Point..........................	41 10 00	71 17 05	20	Ebb	—	10	62
53	8.00	In Long Island Sound 1000 feet off Rocky Point..............................	41 08 45	72 21 30	1	Ebb	—	10	140
54	8.00	In Long Island Sound 1000 feet off Rocky Point..............................	41 08 45	72 21 30	20	Ebb	—	10	80
55	9.00	In Long Island Sound 1000 feet off Hortons Point..............................	41 05 35	72 27 10	1	Ebb	—	12	130
56	9.00	In Long Island Sound 1000 feet off Hortons Point..............................	41 05 35	72 27 10	20	Ebb	—	12	62
57	10.00	In Long Island Sound ½ mile off Duck Pond Point..............................	41 02 45	72 31 30	1	Flood	—	12	160
58	10.00	In Long Island Sound ½ mile off Duck Pond Point..............................	41 02 45	72 31 30	20	Flood	—	12	88
59	11.00	In Long Island Sound, ½ mile off Jacob's Landing............................	41 00 00	72 37 00	1	Flood	—	12	220
60	11.00	In Long Island Sound, ½ mile off Jacob's Landing............................	41 00 00	72 37 00	20	Flood	—	12	108
61	12.00	In Long Island Sound, ½ mile off Roanoke Point...............................	41 00 30	72 42 00	1	Flood	—	14	240
62	12.00	In Long Island Sound, ½ mile off Roanoke Point...............................	41 00 30	72 42 00	20	Flood	—	14	110
63	1.00	In Long Island Sound, ½ mile off Herod's Point............................	40 59 45	72 49 45	1	Flood	—	14	320
64	1.00	In Long Island Sound, ½ mile off Herod's Point............................	40 59 45	72 49 45	20	Flood	—	14	140
65	2.00	In Long Island Sound, ½ mile off Woodville Landing.........................	40 59 50	72 49 45	1	Flood	—	16	380
66	2.00	In Long Island Sound, ½ mile off Woodville Landing.........................	40 59 50	72 49 45	20	Flood	—	16	160
67	3.00	In Long Island Sound, ½ mile off Mt. Misery Point.........................	40 59 30	72 57 30	1	Flood	—	18	640
68	3.00	In Long Island Sound, ½ mile off Mt. Misery Point.........................	40 59 30	72 57 30	20	Flood	—	18	220

TABLE XV—Continued

5—LONG ISLAND SOUND. APRIL 15, 1909

Low water occurred at Governor's Island at 10.00 A. M. The wind was northwest with a velocity from 5 to 15 miles per hour

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
69	4.15	Smithtown bay	40 58 00	73 10 45	1	Flood	—	20	420
70	4.15	Smithtown bay	40 58 00	73 10 45	20	Flood	—	20	180
71	5.00	Long Island Sound, 1 mile off Eaton's Point	40 59 30	73 22 30	1	Flood	—	20	360
72	5.00	Long Island Sound, 1 mile off Eaton's Point	40 59 30	73 22 30	20	Flood	—	20	120
73	6 00	Long Island Sound, 1 mile off Lloyd's Point	40 57 45	73 29 10	1	Flood	—	22	480
74	6.00	Long Island Sound, 1 mile off Lloyd's Point	40 57 45	73 29 10	20	Flood	—	22	220
75	7.00	Long Island Sound, 1 mile off Mattinicock Point	40 55 20	73 38 25	1	Flood	—	24	460
76	7.00	Long Island Sound, 1 mile off Mattinicock Point	40 55 20	73 38 25	20	Flood	—	24	240
77	8.00	Long Island Sound, 1 mile off Prospect Point	40 52 45	73 44 25	1	Ebb	—	26	540
78	8.00	Long Island Sound, 1 mile off Prospect Point	40 52 45	73 44 25	20	Ebb	—	26	320
79	9.00	Long Island Sound, 100 feet off Throgs Neck	40 48 12	73 47 35	1	Ebb	—	30	1,080
80	9.00	Long Island Sound, 100 feet off Throgs Neck	40 48 12	73 47 35	20	Ebb	—	30	540
81	10.00	East river, 500 feet off Clauson Point	40 48 15	73 50 50	1	Ebb	—	36	2,230
82	10.00	East river, 500 feet off Clauson Point	40 48 15	73 50 50	20	Ebb	—	36	1,200
83	11.00	East river, under Williamsburg Bridge	40 42 49	73 58 21	1	Ebb	—	40	10,500
84	11.00	East river, under Williamsburg Bridge	40 42 49	73 58 21	20	Ebb	—	40	3,200

6—THE NARROWS. APRIL 19, 1909

Low water occurred at Governor's Island at 1.35 P. M. The wind was southwest with a velocity of 5 miles per hour.

85	10.15	Near shore, Fort Hamilton	40 36 27	74 02 13	1	Ebb	—	—	6,400
86	10.18	Near shore, Fort Hamilton	40 36 27	74 02 13	10	Ebb	—	—	4,700
87	10.25	¼ way across Narrows from Fort Hamilton	40 36 27	74 02 34	1	Ebb	—	—	5,300
88	10.28	¼ way across Narrows from Fort Hamilton	40 36 27	74 02 34	10	Ebb	—	—	3,700
89	10.31	¼ way across Narrows from Fort Hamilton	40 36 27	74 02 34	20	Ebb	—	—	2,200
90	10.34	¼ way across Narrows from Fort Hamilton	40 36 27	74 02 34	40	Ebb	—	—	950
91	10.40	¼ way across Narrows from Fort Hamilton	40 36 27	74 02 34	80	Ebb	—	—	480
92	10.55	½ way across Narrows	40 36 25	74 02 48	1	Ebb	—	—	4,200
93	10.58	½ way across Narrows	40 36 25	74 02 48	10	Ebb	—	—	2,800
94	11.05	½ way across Narrows	40 36 25	74 02 48	20	Ebb	—	—	1,900
95	11.10	½ way across Narrows	40 36 25	74 02 48	40	Ebb	—	—	840
96	11.15	½ way across Narrows	40 36 25	74 02 48	80	Ebb	—	—	620
97	11.25	¾ way across Narrows from Fort Hamilton	40 36 23	74 03 02	1	Ebb	—	—	19,000
98	11.28	¾ way across Narrows from Fort Hamilton	40 36 23	74 03 02	10	Ebb	—	—	13,000
99	11.31	¾ way across Narrows from Fort Hamilton	40 36 23	74 03 02	20	Ebb	—	—	8,500
100	11.35	¾ way across Narrows from Fort Hamilton	40 36 23	74 03 02	40	Ebb	—	—	2,800
101	11 40	¾ way across Narrows from Fort Hamilton	40 36 23	74 03 02	80	Ebb	—	—	1,600
102	11.50	50 feet from Fort Wadsworth	40 36 21	74 03 13	1	Ebb	—	—	22,000
103	11.53	50 feet from Fort Wadsworth	40 36 21	74 03 13	10	Ebb	—	—	17,000
104	12.00	50 feet from Fort Wadsworth	40 36 21	74 03 13	20	Ebb	—	—	9,500
105	12.05	50 feet from Fort Wadsworth	40 36 20	74 03 14	40	Ebb	—	—	2,200
106	3.32	Near shore, Fort Hamilton	40 36 27	74 02 13	1	Flood	—	—	4,200
107	3.35	Near shore, Fort Hamilton	40 36 27	74 02 13	10	Flood	—	—	2,600
108	3.43	¼ way across Narrows from Fort Hamilton	40 36 27	74 02 34	1	Flood	—	—	3,700
109	3.46	¼ way across Narrows from Fort Hamilton	40 36 27	74 02 34	10	Flood	—	—	3,200
110	3.48	¼ way across Narrows from Fort Hamilton	40 36 27	74 02 34	20	Flood	—	—	2,000
111	3.51	¼ way across Narrows from Fort Hamilton	40 36 27	74 02 34	40	Flood	—	—	850
112	3.54	¼ way across Narrows from Fort Hamilton	40 36 27	74 02 34	80	Flood	—	—	340

TABLE XV—Continued

6—THE NARROWS. APRIL 19, 1909—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
113	4.00	½ way across Narrows	40 36 25	74 02 48	1	Flood	—	—	2,800
114	4.03	½ way across Narrows	40 36 25	74 02 48	10	Flood	—	—	1,900
115	4.05	½ way across Narrows	40 36 25	74 02 48	20	Flood	—	—	1,600
116	4.07	½ way across Narrows	40 36 25	74 02 48	40	Flood	—	—	550
117	4.10	½ way across Narrows	40 36 25	74 02 48	80	Flood	—	—	380
118	4.16	¾ way across Narrows from Fort Hamilton	40 36 23	74 03 02	1	Flood	—	—	4,200
119	4.18	¾ way across Narrows from Fort Hamilton	40 36 23	74 03 02	10	Flood	—	—	3,800
120	4.20	¾ way across Narrows from Fort Hamilton	40 36 23	74 03 02	20	Flood	—	—	2,200
121	4.23	¾ way across Narrows from Fort Hamilton	40 36 23	74 03 02	40	Flood	—	—	1,200
122	4.25	¾ way across Narrows from Fort Hamilton	40 36 23	74 03 02	80	Flood	—	—	480
123	4.31	50 feet from Fort Wadsworth	40 36 20	74 03 14	1	Flood	—	—	5,600
124	4.34	50 feet from Fort Wadsworth	40 36 20	74 03 14	10	Flood	—	—	4,200
125	4.37	50 feet from Fort Wadsworth	40 36 20	74 03 14	20	Flood	—	—	2,600
126	4.40	50 feet from Fort Wadsworth	40 36 20	74 03 14	40	Flood	—	—	860

7—EAST RIVER. APRIL 22, 1909

High water occurred at Governor's Island at 9.49 A. M. The wind was southwest with a velocity of 5 miles per hour from 8.05 A. M. until 1.55 P. M. From 1.55 P. M. the velocity was 15 miles per hour.

127	8.05	30 feet off Pier 10, Manhattan	40 42 10	74 00 23	1	Flood	—	—	8,500
128	8.08	30 feet off Pier 10, Manhattan	40 42 10	74 00 23	10	Flood	—	—	7,400
129	8.12	30 feet off Pier 10, Manhattan	40 42 10	74 00 23	20	Flood	—	—	5,300
130	8.17	30 feet off Pier 10, Manhattan	40 42 10	74 00 23	35	Flood	—	—	3,200
131	8.25	¼ way across East river, Pier 10, Manhattan	40 42 07	74 00 17	1	Flood	—	—	7,700
132	8.28	¼ way across East river, Pier 10, Manhattan	40 42 07	74 00 17	10	Flood	—	—	6,900
133	8.32	¼ way across East river, Pier 10, Manhattan	40 42 07	74 00 17	20	Flood	—	—	6,400
134	8.37	¼ way across East river, Pier 10, Manhattan	40 42 07	74 00 17	40	Flood	—	—	5,800
135	8.45	½ way across East river	40 42 03	74 00 11	1	Flood	—	—	7,200
136	8.48	½ way across East river	40 42 03	74 00 11	10	Flood	—	—	5,800
137	8.52	½ way across East river	40 42 03	74 00 11	20	Flood	—	—	5,800
138	8.57	½ way across East river	40 42 03	74 00 11	40	Flood	—	—	3,700
139	9.10	¾ way across East river, Pier 10, Manhattan	40 42 00	74 00 05	1	Flood	—	—	10,000
140	9.13	¾ way across East river, Pier 10, Manhattan	40 42 00	74 00 05	10	Flood	—	—	7,900
141	9.18	¾ way across East river, Pier 10, Manhattan	40 42 00	74 00 05	20	Flood	—	—	7,400
142	9.23	¾ way across East river, Pier 10, Manhattan	40 42 00	74 00 05	40	Flood	—	—	6,400
143	9.30	30 feet off pier, Brooklyn	40 41 57	73 59 59	1	Flood	—	—	13,000
144	9.33	30 feet off pier, Brooklyn	40 41 57	73 59 59	10	Flood	—	—	5,300
145	9.37	30 feet off pier, Brooklyn	40 41 57	73 59 59	20	Flood	—	—	4,800
146	9.42	30 feet off pier, Brooklyn	40 41 57	73 59 59	40	Flood	—	—	4,200
147	1.00	30 feet off Pier 10, Manhattan	40 42 10	74 00 23	1	Ebb	—	—	10,000
148	1.02	30 feet off Pier 10, Manhattan	40 42 10	74 00 23	10	Ebb	—	—	7,900
149	1.05	30 feet off Pier 10, Manhattan	40 42 10	74 00 23	20	Ebb	—	—	6,400
150	1.08	30 feet off Pier 10, Manhattan	40 42 10	74 00 23	35	Ebb	—	—	4,800
151	1.12	¼ way across East river, Pier 10, Manhattan	40 42 07	74 00 17	1	Ebb	—	—	8,000
152	1.14	¼ way across East river, Pier 10, Manhattan	40 42 07	74 00 17	10	Ebb	—	—	7,400
153	1.17	¼ way across East river, Pier 10, Manhattan	40 42 07	74 00 17	20	Ebb	—	—	6,400
154	1.20	¼ way across East river, Pier 10, Manhattan	40 42 07	74 00 17	40	Ebb	—	—	5,300
155	1.25	½ way across East river	40 42 03	74 00 11	1	Ebb	—	—	10,000
156	1.27	½ way across East river	40 42 03	74 00 11	10	Ebb	—	—	9,400
157	1.30	½ way across East river	40 42 03	74 00 11	20	Ebb	—	—	6,400
158	1.33	½ way across East river	40 42 03	74 00 11	40	Ebb	—	—	5,300

TABLE XV—Continued

7—EAST RIVER. APRIL 22, 1909—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
159	1.40	¾ way across East river from Pier 10, Manhattan	40 42 00	74 00 05	1	Ebb	—	—	10,200
160	1.42	¾ way across East river from Pier 10, Manhattan	40 42 00	74 00 05	10	Ebb	—	—	9,500
161	1.45	¾ way across East river from Pier 10, Manhattan	40 42 00	74 00 05	20	Ebb	—	—	8,500
162	1.48	¾ way across East river from Pier 10, Manhattan	40 42 00	74 00 05	40	Ebb	—	—	5,800
163	1.55	30 feet off Pier 10, Brooklyn	40 41 57	73 59 59	1	Ebb	—	—	15,900
164	1.57	30 feet off Pier 10, Brooklyn	40 41 57	73 59 59	10	Ebb	—	—	10,000
165	2.00	30 feet off Pier 10, Brooklyn	40 41 57	73 59 59	20	Ebb	—	—	7,900
166	2.05	30 feet off Pier 10, Brooklyn	40 41 57	73 59 59	40	Ebb	—	—	7,400

8—KILL VAN KULL. APRIL 26, 1909

High water occurred at Governors Island at 1.39 P. M. The wind was northwest from 9.50 A. M. until 11.00 A. M. with a velocity of 10 miles per hour. From 3.04 P. M. to 4.10 P. M. the wind was northeast with a velocity of 15 miles per hour.

Sample No.	Hour P. M.	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
167	9.50	20 feet off Columbia Oil Co. Pier, Bayonne	40 39 02	74 05 26	1	Flood	—	—	6,400
168	9.53	20 feet off Columbia Oil Co. Pier, Bayonne	40 39 02	74 05 26	10	Flood	—	—	4,200
169	9.57	20 feet off Columbia Oil Co. Pier, Bayonne	40 39 02	74 05 26	20	Flood	—	—	3,700
170	10.03	¼ way from Bayonne	40 39 00	74 05 26	1	Flood	—	—	5,300
171	10.05	¼ way from Bayonne	40 39 00	74 05 26	10	Flood	—	—	3,200
172	10.08	¼ way from Bayonne	40 39 00	74 05 26	20	Flood	—	—	2,600
173	10.12	¼ way from Bayonne	40 39 00	74 05 26	40	Flood	—	—	1,600
174	10.17	½ way across Kill van Kull	40 38 57	74 05 25	1	Flood	—	—	7,400
175	10.19	½ way across Kill van Kull	40 38 57	74 04 25	10	Flood	—	—	6,400
176	10.23	½ way across Kill van Kull	40 38 57	74 05 25	20	Flood	—	—	4,200
177	10.28	½ way across Kill van Kull	40 38 57	74 05 25	40	Flood	—	—	3,200
178	10.33	¾ way across from Bayonne	40 38 54	74 05 24	1	Flood	—	—	10,000
179	10.35	¾ way across from Bayonne	40 38 54	74 05 24	10	Flood	—	—	7,900
180	10.38	¾ way across from Bayonne	40 38 54	74 05 24	20	Flood	—	—	5,800
181	10.45	¾ way across from Bayonne	40 38 54	74 05 24	40	Flood	—	—	4,800
182	10.55	20 feet off dock foot Jersey street, New Brighton, S. I.	40 38 51	74 05 23	1	Flood	—	—	12,900
183	11.00	20 feet off dock foot Jersey street, New Brighton, S. I.	40 38 51	74 05 23	10	Flood	—	—	7,400
184	3.04	20 feet from Columbia Oil Co. Pier, Bayonne	40 39 02	74 05 26	1	Ebb	—	—	8,500
185	3.07	20 feet from Columbia Oil Co. Pier, Bayonne	40 39 02	74 05 26	10	Ebb	—	—	6,900
186	3.10	20 feet from Columbia Oil Co. Pier, Bayonne	40 39 02	74 05 26	20	Ebb	—	—	4,200
187	3.18	¼ way across Kill van Kull from Bayonne	40 39 02	74 05 26	1	Ebb	—	—	7,900
188	3.22	¼ way across Kill van Kull from Bayonne	40 39 00	74 05 26	10	Ebb	—	—	6,900
189	3.25	¼ way across Kill van Kull from Bayonne	40 39 00	74 05 26	20	Ebb	—	—	5,800
190	3.28	¼ way across Kill van Kull from Bayonne	40 39 00	74 05 26	40	Ebb	—	—	3,700
191	3.36	½ way across Kill van Kull	40 38 57	74 05 25	1	Ebb	—	—	10,600
192	3.39	½ way across Kill van Kull	40 38 57	74 05 25	10	Ebb	—	—	8,500
193	3.42	½ way across Kill van Kull	40 38 57	74 05 25	20	Ebb	—	—	6,400
194	3.45	½ way across Kill van Kull	40 38 57	74 05 25	40	Ebb	—	—	4,800
195	3.52	¾ way across Kill van Kull from Bayonne	40 38 54	74 05 24	1	Ebb	—	—	13,000
196	3.54	¾ way across Kill van Kull from Bayonne	40 38 54	74 05 24	10	Ebb	—	—	10,600
197	3.57	¾ way across Kill van Kull from Bayonne	40 38 54	74 05 24	20	Ebb	—	—	9,000
198	4.00	¾ way across Kill van Kull	40 38 54	74 05 24	40	Ebb	—	—	6,400
199	4.05	20 feet off dock foot Jersey street, New Brighton, S. I.	40 38 51	74 05 23	1	Ebb	—	—	15,900
200	4.10	20 feet off dock foot Jersey street, New Brighton, S. I.	40 38 51	74 05 23	10	Ebb	—	—	11,000

TABLE XV—Continued

9—HARLEM RIVER. APRIL 27, 1909

High water occurred at Governor's Island at 2.32 P. M. The wind was northwest with a velocity of 5 miles per hour.

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
201	11.05	At Third avenue bridge, 10 feet from east shore	40 28 27	73 55 55	1	Flood	—	—	20,000
202	11.08	At Third avenue bridge, 10 feet from east shore	40 28 27	73 55 55	10	Flood	—	—	13,000
203	11.16	At Third avenue bridge, ¼ way across from east shore	40 48 26	73 55 56	1	Flood	—	—	18,000
204	11.19	At Third avenue bridge, ¼ way across from east shore	40 48 26	73 55 56	10	Flood	—	—	14,000
205	11.22	At Third avenue bridge, ¼ way across from east shore	40 48 26	73 55 56	20	Flood	—	—	10,000
206	11.30	At Third avenue bridge, midstream	40 48 25	73 55 57	1	Flood	—	—	12,000
207	11.32	At Third avenue bridge, midstream	40 48 25	73 55 57	10	Flood	—	—	8,500
208	11.35	At Third avenue bridge, midstream	40 48 25	73 55 57	20	Flood	—	—	6,400
209	11.44	At Third avenue bridge, ¾ way across from east shore	40 48 25	73 55 58	1	Flood	—	—	13,000
210	11.47	At Third avenue bridge, ¾ way across from east shore	40 48 25	73 55 58	10	Flood	—	—	9,500
211	11.50	At Third avenue bridge, ¾ way across from east shore	40 48 25	73 55 58	20	Flood	—	—	6,400
212	12.00	At Third avenue bridge, 10 feet from west shore	40 48 25	73 56 00	1	Flood	—	—	19,000
213	12.02	At Third avenue bridge, 10 feet from west shore	40 48 25	73 56 00	10	Flood	—	—	14,000
214	12.05	At Third avenue bridge, 10 feet from west shore	40 48 25	73 56 00	18	Flood	—	—	7,400
215	4.34	At Third avenue bridge, 10 feet from east shore	40 48 27	73 55 55	1	Ebb	—	—	13,000
216	4.36	At Third avenue bridge, 10 feet from east shore	40 48 27	73 55 55	10	Ebb	—	—	9,500
217	4.42	At Third avenue bridge, ¼ way across from east shore	40 48 26	73 55 56	1	Ebb	—	—	11,000
218	4.44	At Third avenue bridge, ¼ way across from east shore	40 48 26	73 55 56	10	Ebb	—	—	8,500
219	4.46	At Third avenue bridge, ¼ way across from east shore	40 48 26	73 55 56	20	Ebb	—	—	5,300
220	4.50	At Third avenue bridge, midstream	40 48 25	73 55 57	1	Ebb	—	—	9,500
221	4.52	At Third avenue bridge, midstream	40 48 25	73 55 57	10	Ebb	—	—	7,400
222	4.54	At Third avenue bridge, midstream	40 48 25	73 55 57	20	Ebb	—	—	4,200
223	4.58	At Third avenue bridge, ¾ way across from east shore	40 48 25	73 55 58	1	Ebb	—	—	12,000
224	5.00	At Third avenue bridge, ¾ way across from east shore	40 48 25	73 55 58	10	Ebb	—	—	9,000
225	5.02	At Third avenue bridge, ¾ way across from east shore	40 48 25	73 55 58	20	Ebb	—	—	6,400
226	5.06	At Third avenue bridge, 10 feet from west shore	40 48 25	73 56 00	1	Ebb	—	—	17,000
227	5.08	At Third avenue bridge, 10 feet from west shore	40 48 25	73 56 00	10	Ebb	—	—	11,000
228	5.10	At Third avenue bridge, 10 feet from west shore	40 48 25	73 56 00	18	Ebb	—	—	7,400

TABLE XV—Continued

10—HUDSON RIVER. MAY 3, 1909

Low water occurred at Governor's Island at 12.55 P. M. The wind was southeast with a velocity of from 20 to 50 miles per hour.

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
229	12.05	50 feet off pier on New Jersey shore, opposite Riverdale station	40 54 14	73 55 58	1	Ebb	—	—	5,800
230	12.08	50 feet off pier on New Jersey shore, opposite Riverdale station	40 54 14	73 55 58	10	Ebb	—	—	5,200
231	12.11	50 feet off pier on New Jersey shore, opposite Riverdale station	40 54 14	73 55 58	16	Ebb	—	—	4,400
232	12.25	¼ way across Hudson river from New Jersey shore	40 54 12	73 55 42	1	Ebb	—	—	5,300
233	12.28	¼ way across Hudson river from New Jersey shore	40 54 12	73 55 42	10	Ebb	—	—	4,700
234	12.32	¼ way across Hudson river from New Jersey shore	40 54 12	73 55 42	20	Ebb	—	—	3,700
235	1.00	½ way across Hudson river	40 54 08	73 55 28	1	Ebb	—	—	6,200
236	1.03	½ way across Hudson river	40 54 08	73 55 28	10	Ebb	—	—	5,300
237	1.08	½ way across Hudson river	40 54 08	73 55 28	20	Ebb	—	—	4,400
238	1.12	½ way across Hudson river	40 54 08	73 55 28	30	Ebb	—	—	2,700
239	1.25	¾ way across Hudson river from New Jersey shore	40 54 06	73 55 10	1	Ebb	—	—	8,400
240	1.28	¾ way across Hudson river from New Jersey shore	40 54 06	73 55 10	10	Ebb	—	—	6,400
241	1.32	¾ way across Hudson river from New Jersey shore	40 54 06	73 55 10	20	Ebb	—	—	4,200
242	1.37	¾ way across Hudson river from New Jersey shore	40 54 06	73 55 10	40	Ebb	—	—	3,700
243	1.54	30 feet off pier at Riverdale station	40 54 03	73 54 57	1	Ebb	—	—	12,000
244	1.57	30 feet off pier at Riverdale station	40 54 03	73 54 57	10	Ebb	—	—	8,500
245	5.15	50 feet off pier, New Jersey, opposite Riverdale station	40 54 14	73 55 58	1	Flood	—	—	4,900
246	5.17	50 feet off pier, New Jersey, opposite Riverdale station	40 54 14	73 55 58	10	Flood	—	—	3,800
247	5.20	50 feet off pier, New Jersey, opposite Riverdale station	40 54 14	73 55 58	18	Flood	—	—	3,200
248	5.27	¼ way across Hudson from New Jersey shore	40 54 12	73 55 42	1	Flood	—	—	4,700
249	5.29	¼ way across Hudson from New Jersey shore	40 54 12	73 55 42	10	Flood	—	—	4,200
250	5.32	¼ way across Hudson from New Jersey shore	40 54 12	73 55 42	20	Flood	—	—	2,700
251	5.42	½ way across Hudson river	40 54 08	73 55 28	1	Flood	—	—	5,300
252	5.44	½ way across Hudson river	40 54 08	73 55 28	10	Flood	—	—	4,700
253	5.47	½ way across Hudson river	40 54 08	73 55 28	20	Flood	—	—	3,700
254	5.50	½ way across Hudson river	40 54 08	73 55 28	30	Flood	—	—	3,200
255	5.59	¾ way across Hudson river from New Jersey shore	40 54 06	73 55 10	1	Flood	—	—	6,800
256	6.02	¾ way across Hudson river from New Jersey shore	40 54 06	73 55 10	10	Flood	—	—	6,400
257	6.05	¾ way across Hudson river from New Jersey shore	40 54 06	73 55 10	20	Flood	—	—	3,700
258	6.08	¾ way across Hudson river from New Jersey shore	40 54 06	73 55 10	40	Flood	—	—	4,200
259	6.16	30 feet off pier at Riverdale station, N. Y. C. R.R.	40 54 03	73 54 57	1	Flood	—	—	7,400
260	6.20	30 feet off pier at Riverdale station, N. Y. C. R.R.	40 54 03	73 54 57	10	Flood	—	—	5,800

TABLE XV—Continued

11—HUDSON RIVER. MAY 4, 1909

Low water occurred at Governors Island at 1.53 P. M. The wind was southwest with a velocity of 5 miles per hour.

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
261	10.00	Hudson river, midstream, opposite Riverdale station, N. Y. C. R.R.	40 54 08	73 55 28	1	Ebb	—	—	7,400
262	10.03	Hudson river, midstream, opposite Riverdale station, N. Y. C. R.R.	40 54 08	73 55 28	10	Ebb	—	—	5,800
263	10.05	Hudson river, midstream, opposite Riverdale station, N. Y. C. R.R.	40 54 08	73 55 28	30	Ebb	—	—	3,700
264	10.20	1000 feet off east shore opposite Spuyten Duyvil Creek	40 52 48	73 55 45	1	Ebb	—	—	5,800
265	10.22	1000 feet off east shore opposite Spuyten Duyvil Creek	40 52 48	73 55 45	10	Ebb	—	—	4,700
266	10.24	1000 feet off east shore opposite Spuyten Duyvil Creek	40 52 48	73 55 45	30	Ebb	—	—	3,200
267	10.34	1000 feet off east shore, Innwood station, N. Y. C. R.R.	40 52 13	73 56 09	1	Ebb	—	—	5,300
268	10.35	1000 feet off east shore, Innwood station, N. Y. C. R.R.	40 52 13	73 56 09	10	Ebb	—	—	4,200
269	10.37	1000 feet off east shore, Innwood station, N. Y. C. R.R.	40 52 13	73 56 09	30	Ebb	—	—	2,600
270	10.57	500 feet off east shore opposite Fort Washington Point	40 51 02	73 56 55	1	Ebb	—	—	5,400
271	10.58	500 feet off east shore opposite Fort Washington Point	40 51 02	73 56 55	10	Ebb	—	—	4,700
272	11.00	500 feet off east shore opposite Fort Washington Point	40 51 02	73 56 55	30	Ebb	—	—	4,200
273	11.14	1000 feet off east shore opposite West 157th street	40 50 14	73 57 09	1	Ebb	—	—	5,800
274	11.15	1000 feet off east shore opposite West 157th street	40 50 14	73 57 09	10	Ebb	—	—	6,400
275	11.17	1000 feet off east shore opposite West 157th street	40 50 14	73 57 09	30	Ebb	—	—	3,700
276	11.47	1000 feet off east shore opposite West 92d street	40 47 44	73 58 55	1	Ebb	—	—	6,600
277	11.48	1000 feet off east shore opposite West 92d street	40 47 44	73 58 55	10	Ebb	—	—	5,300
278	11.50	1000 feet off east shore opposite West 92d street	40 47 44	73 58 55	30	Ebb	—	—	2,800
279	12.20	1000 feet off east shore opposite West 62d street	40 46 37	73 59 51	1	Ebb	—	—	7,400
280	12.21	1000 feet off east shore opposite West 62d street	40 46 37	73 59 51	10	Ebb	—	—	5,800
281	12.23	1000 feet off east shore opposite West 62d street	40 46 37	73 59 51	30	Ebb	—	—	3,700
282	12.43	1000 feet off east shore opposite West 42d street	40 45 50	74 00 22	1	Ebb	—	—	8,500
283	12.44	1000 feet off east shore opposite West 42d street	40 45 50	74 00 22	10	Ebb	—	—	7,600
284	12.46	1000 feet off east shore opposite West 42d street	40 45 50	74 00 22	30	Ebb	—	—	3,200
285	1.04	200 feet off east shore opposite West 23d street	40 45 03	74 00 43	1	Ebb	—	—	9,500
286	1.05	200 feet off east shore opposite West 23d street	40 45 03	74 00 43	10	Ebb	—	—	7,900
287	1.07	200 feet off east shore opposite West 23d street	40 45 03	74 00 43	30	Ebb	—	—	4,200
288	1.22	200 feet off east shore opposite Gansevoort street	40 44 21	74 00 51	1	Ebb	—	—	6,400
289	1.23	200 feet off east shore opposite Gansevoort street	40 44 21	74 00 51	10	Ebb	—	—	8,000

TABLE XV—Continued

11—HUDSON RIVER. MAY 4, 1909—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
290	1.25	200 feet off east shore opposite Gansvoort street	40 44 21	74 00 51	30	Ebb	—	—	3,600
291	1.40	200 feet off east shore opposite Pier 37, Charlton street	40 43 41	74 00 55	1	Ebb	—	—	9,000
292	1.41	200 feet off east shore opposite Pier 37, Charlton street	40 43 41	74 00 55	10	Ebb	—	—	8,200
293	1.43	200 feet off east shore opposite Pier 37, Charlton street	40 43 41	74 00 55	30	Ebb	—	—	4,700
294	2.03	200 feet off east shore opposite Pier 21, Duane street	40 43 06	74 01 01	1	Ebb	—	—	9,500
295	2.04	200 feet off east shore opposite Pier 21, Duane street	40 43 06	74 01 01	10	Ebb	—	—	9,000
296	2.05	200 feet off east shore opposite Pier 21, Duane street	40 43 06	74 01 01	30	Ebb	—	—	5,300
297	2.16	300 feet off east shore opposite Liberty street	40 42 41	74 01 03	1	Ebb	—	—	9,200
298	2.17	300 feet off east shore opposite Liberty street	40 42 41	74 01 03	10	Ebb	—	—	7,900
299	2.18	300 feet off east shore opposite Liberty street	40 42 41	74 01 03	30	Ebb	—	—	4,600
300	2.28	100 feet off east shore opposite Pier A	40 42 16	74 01 09	1	Ebb	—	—	10,500
301	2.30	100 feet off east shore opposite Pier A	40 42 16	74 01 09	10	Ebb	—	—	8,500
302	2.32	100 feet off east shore opposite Pier A	40 42 16	74 01 09	30	Ebb	—	—	4,200
303	2.45	500 feet west of Castle William, Governors Island	40 41 35	74 01 19	1	Ebb	—	—	6,800
304	2.47	500 feet west of Castle William, Governors Island	40 41 35	74 01 19	10	Ebb	—	—	4,800
305	2.50	500 feet west of Castle William, Governors Island	40 41 35	74 01 19	30	Ebb	—	—	2,600

12—NEWARK BAY AND PASSAIC RIVER. MAY 10, 1909

High water at Governors Island at 11.41 A. M. The wind until 1.02 P. M. was south with a velocity of 10 miles per hour. At 3.45 P. M. the velocity was 40 miles per hour.

306	10.45	200 feet from Bergen Point shore at C. R.R. of N. J. bridge	40 39 17	74 08 26	1	Flood	—	—	6,400
307	10.47	200 feet from Bergen Point shore at C. R.R. of N. J. bridge	40 39 17	74 08 06	10	Flood	—	—	5,300
308	10.53	¼ way across Newark bay near drawbridge C. R.R. of N. J.	40 39 17	74 08 46	1	Flood	—	—	4,800
309	10.55	¼ way across Newark bay near drawbridge C. R.R. of N. J.	40 39 17	74 08 46	10	Flood	—	—	3,700
310	10.57	¼ way across Newark bay near drawbridge C. R.R. of N. J.	40 39 17	74 08 46	20	Flood	—	—	3,200
311	11.03	½ way across Newark bay on line C. R.R. of N. J. bridge	40 39 17	74 09 14	1	Flood	—	—	2,800
312	11.05	½ way across Newark bay on line C. R.R. of N. J. bridge	40 39 17	74 09 14	10	Flood	—	—	2,200
313	11.10	¾ way across Newark bay from east shore	40 39 17	74 09 40	1	Flood	—	—	5,400
314	11.12	¾ way across Newark bay from east shore	40 39 17	74 09 40	10	Flood	—	—	4,200
315	11.18	300 feet from west shore, Elizabethport	40 39 18	74 10 02	1	Flood	—	—	6,700
316	11.20	300 feet from west shore, Elizabethport	40 39 18	74 10 02	10	Flood	—	—	5,200
317	11.35	At red bell buoy in channel between C. R.R. of N. J. and B. & O. R.R. bridge	40 40 15	74 08 10	1	Flood	—	—	3,500
318	11.37	At red bell buoy in channel between C. R.R. of N. J. and B. & O. R.R. bridge	40 40 15	74 08 10	10	Flood	—	—	3,100
319	11.40	At red bell buoy in channel between C. R.R. of N. J. and B. & O. R.R. bridge	40 40 15	74 08 10	20	Flood	—	—	1,100

TABLE XV—Continued

12—NEWARK BAY AND PASSAIC RIVER. MAY 10, 1909—Continued

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
320	12.00	At drawbridge B. & O. R.R. bridge in channel of bay	40 41 56	74 07 15	1	Flood	—	—	6,400
321	12.02	At drawbridge B. & O. R.R. bridge in channel of bay	40 41 56	74 07 15	10	Flood	—	—	5,000
322	12.05	At drawbridge B. & O. R.R. bridge in channel of bay	40 41 56	74 07 15	20	Flood	—	—	2,600
323	12.20	Passaic river at drawbridge N. Y. & Newark R.R. in channel	40 43 21	74 07 18	1	Flood	—	—	12,500
324	12.22	Passaic river at drawbridge N. Y. & Newark R.R. in channel	40 43 21	74 07 18	10	Flood	—	—	10,000
325	12.38	Passaic river just above P. R.R. freight bridge	40 44 10	74 09 45	1	Flood	—	—	15,000
326	12.40	Passaic river just above P. R.R. freight bridge, below Newark	40 44 10	74 09 45	10	Flood	—	—	13,000
327	1 00	Passaic river, just below P. R.R. passenger bridge in Newark	40 44 49	74 09 56	1	Flood	—	—	24,000
328	1.02	Passaic river, just below P. R.R. passenger bridge in Newark	40 44 49	74 09 56	10	Flood	—	—	11,000
329	3 10	Passaic river, just below P. R.R. passenger bridge in Newark	40 44 49	74 09 56	1	Ebb	—	—	60,000
330	3.12	Passaic river, just below P. R.R. passenger bridge in Newark	40 44 49	74 09 56	10	Ebb	—	—	31,000
331	3 33	Passaic river, just above P. R.R. freight bridge below Newark	40 44 10	74 09 45	1	Ebb	—	—	26,000
332	3.35	Passaic river, just above P. R.R. freight bridge below Newark	40 44 10	74 09 45	10	Ebb	—	—	21,000
333	3.45	Passaic river at drawbridge, N. Y. & Newark R.R. in channel	40 43 21	74 07 18	1	Ebb	—	—	18,000
334	3.47	Passaic river at drawbridge, N. Y. & Newark R.R. in channel	40 43 21	74 07 18	10	Ebb	—	—	12,000
335	4.00	At drawbridge of B. & O. R.R. bridge in channel of Newark bay	40 41 56	74 07 15	1	Ebb	—	—	24,000
336	4.02	At drawbridge of B. & O. R.R. bridge in channel of Newark bay	40 41 56	74 07 15	10	Ebb	—	—	13,000
337	4.04	At drawbridge of B. & O. R.R. bridge in channel of Newark bay	40 41 56	74 07 15	20	Ebb	—	—	5,500
338	4.20	At red bell buoy in channel in bay between C. R.R. of N. J. and B. & O. R.R. bridges	40 40 15	74 08 10	1	Ebb	—	—	8,500
339	4.22	At red bell buoy in channel in bay between C. R.R. of N. J. and B. & O. R.R. bridges	40 40 15	74 08 10	10	Ebb	—	—	5,700
340	4.24	At red bell buoy in channel in bay between C. R.R. of N. J. and B. & O. R.R. bridges	40 40 15	74 08 10	20	Ebb	—	—	4,200
341	4.35	200 feet from Bergen Point shore at C. R.R. of N. J. bridge	40 39 17	74 08 26	1	Ebb	—	—	8,400
342	4.37	200 feet from Bergen Point shore at C. R.R. of N. J. bridge	40 39 17	74 08 26	10	Ebb	—	—	6,200
343	4.42	At drawbridge, C. R.R. of N. J. in channel about ¼ way across bay	40 39 17	74 08 46	1	Ebb	—	—	5,300
344	4.44	At drawbridge, C. R.R. of N. J. in channel about ¼ way across bay	40 39 17	74 08 46	10	Ebb	—	—	4,200
345	4.46	At drawbridge, C. R.R. of N. J. in channel about ¼ way across bay	40 39 17	74 08 46	20	Ebb	—	—	2,800
346	4.51	½ way across Newark bay on line C. R.R. of N. J. bridge	40 39 17	74 09 14	1	Ebb	—	—	4,700
347	4.53	½ way across Newark bay on line C. R.R. of N. J. bridge	40 39 17	74 09 14	10	Ebb	—	—	3,600
348	4.58	¾ way across Newark bay from east shore	40 39 17	74 09 40	1	Ebb	—	—	6,800
349	5.00	¾ way across Newark bay from east shore	40 39 17	74 09 40	10	Ebb	—	—	5,500

TABLE XV—Continued

13—HUDSON RIVER. MAY 11, 1909

High water occurred at Governor's Island at 12.21 P. M. The wind was north with a velocity of 40 miles per hour.

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
350	9.14	50 feet off Pier A, Hudson river...........	40 42 16	74 01 08	1	Ebb	—	—	17,000
351	9.15	50 feet off Pier A, Hudson river...........	40 42 16	74 01 08	10	Ebb	—	—	12,500
352	9.16	50 feet off Pier A, Hudson river...........	40 42 16	74 01 08	20	Ebb	—	—	9,700
353	9.18	50 feet off Pier A, Hudson river...........	40 42 16	74 01 08	40	Ebb	—	—	7,300
354	9.23	¼ way across Hudson river from Pier A...	40 42 17	74 01 20	1	Ebb	—	—	14,500
355	9.24	¼ way across Hudson river from Pier A...	40 42 17	74 01 20	10	Ebb	—	—	10,500
356	9.25	¼ way across Hudson river from Pier A...	40 42 17	74 01 20	20	Ebb	—	—	8,400
357	9.27	¼ way across Hudson river from Pier A...	40 42 17	74 01 20	40	Ebb	—	—	6,600
358	9.32	½ way across Hudson river.............	40 42 19	74 01 34	1	Ebb	—	—	11,000
359	9.33	½ way across Hudson river.............	40 42 19	74 01 34	10	Ebb	—	—	9,500
360	9.34	½ way across Hudson river.............	40 42 19	74 01 34	20	Ebb	—	—	8,600
361	9.36	½ way across Hudson river.............	40 42 19	74 01 34	40	Ebb	—	—	5,300
362	9.41	¾ way across Hudson river from Pier A..	40 42 21	74 01 48	1	Ebb	—	—	9,500
363	9.42	¾ way across Hudson river from Pier A...	40 42 21	74 01 48	10	Ebb	—	—	8,200
364	9.43	¾ way across Hudson river from Pier A...	40 42 21	74 01 48	20	Ebb	—	—	7,200
365	9.45	¾ way across Hudson river from Pier A...	40 42 21	74 01 48	40	Ebb	—	—	4,800
366	9.50	50 ft. from C.R.R. of N. J., Pier 5, Jersey City.	40 42 22	74 02 01	1	Ebb	—	—	13,000
367	9.52	50 ft. from C.R.R. of N. J., Pier 5, Jersey City.	40 42 22	74 02 01	10	Ebb	—	—	11,500
368	9.54	50 ft. from C.R.R. of N. J., Pier 5, Jersey City.	40 42 22	74 02 01	20	Ebb	—	—	7,800

14—HUDSON RIVER. MAY 12, 1909

High water at Governor's Island at 1.21 P. M. The wind was southwest with a velocity of 5 miles per hour.

369	3.15	50 feet off Pier A, Hudson river...........	40 42 16	74 01 08	1	Flood	—	—	8,600
370	3.16	50 feet off Pier A, Hudson river...........	40 42 16	74 01 08	10	Flood	—	—	7,900
371	3.17	50 feet off Pier A, Hudson river...........	40 42 16	74 01 08	20	Flood	—	—	6,800
372	3.19	50 feet off Pier A, Hudson river...........	40 42 16	74 01 08	40	Flood	—	—	5,200
373	3.23	¼ way across Hudson river from Pier A...	40 42 17	74 01 20	1	Flood	—	—	7,800
374	3.24	¼ way across Hudson river from Pier A...	40 42 17	74 01 20	10	Flood	—	—	7,100
375	3.25	¼ way across Hudson river from Pier A...	40 42 17	74 01 20	20	Flood	—	—	5,400
376	3.27	¼ way across Hudson river from Pier A...	40 42 17	74 01 20	40	Flood	—	—	5,200
377	3.31	½ way across Hudson river..............	40 42 19	74 01 34	1	Flood	—	—	6,400
378	3.32	½ way across Hudson river..............	40 42 19	74 01 34	10	Flood	—	—	6,200
379	3.33	½ way across Hudson river..............	40 42 19	74 01 34	20	Flood	—	—	4,700
380	3.35	½ way across Hudson river..............	40 42 19	74 01 34	40	Flood	—	—	3,800
381	3.39	¾ way across Hudson river from Pier A...	40 42 21	74 01 48	1	Flood	—	—	5,800
382	3.40	¾ way across Hudson river from Pier A...	40 42 21	74 01 48	10	Flood	—	—	5,300
383	3.41	¾ way across Hudson river from Pier A...	40 42 21	74 01 48	20	Flood	—	—	4,700
384	3.43	¾ way across Hudson river from Pier A...	40 42 21	74 01 08	40	Flood	—	—	3,800
385	3.47	50 ft. from C.R.R. of N. J., Pier 5, Jersey City.	40 42 22	74 02 01	1	Flood	—	—	7,200
386	3.48	50 ft. from C.R.R. of N. J., Pier 5, Jersey City.	40 42 22	74 02 01	10	Flood	—	—	5,800
387	3.50	50 ft. from C.R.R. of N. J., Pier 5, Jersey City.	40 42 22	74 02 01	20	Flood	—	—	4,700

15—UPPER BAY, LOWER BAY AND ATLANTIC OCEAN. MAY 13, 1909

High water occurred at Governor's Island at 2.40 P. M. The wind was south with a velocity of 5 miles per hour.

388	9.00	At red spar buoy in Hudson river, opposite Pier A..............................	40 42 12	74 01 19	1	Ebb	—	—	18,000
389	9.01	At red spar buoy in Hudson river, opposite Pier A..............................	40 42 12	74 01 19	10	Ebb	—	—	14,000

TABLE XV—Continued

15—UPPER BAY, LOWER BAY AND ATLANTIC OCEAN. MAY 13, 1909—Continued

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
390	9.02	At red spar buoy in Hudson river, opposite Pier A	40 42 12	74 01 19	20	Ebb	—	—	11,000
391	9.04	At red spar buoy in Hudson river, opposite Pier A	40 42 12	74 01 19	40	Ebb	—	—	8,500
392	9.20	Upper bay, by spar buoy A, off Red Hook, Brooklyn	40 40 43	74 01 45	1	Ebb	—	—	12,000
393	9.21	Upper bay, by spar buoy A, off Red Hook, Brooklyn	40 40 43	74 01 45	10	Ebb	—	—	10,000
394	9.22	Upper bay, by spar buoy A, off Red Hook, Brooklyn	40 40 43	74 01 45	20	Ebb	—	—	7,500
395	9.25	Upper bay, by spar buoy A, off Red Hook, Brooklyn	40 40 43	74 01 45	36	Ebb	—	—	6,400
396	9.46	Upper bay by bell buoy N 12½	40 38 23	74 03 14	1	Ebb	—	—	8,500
397	9.47	Upper bay by bell buoy N 12½	40 38 23	74 03 14	10	Ebb	—	—	7,500
398	9.48	Upper bay by bell buoy N 12½	40 38 23	74 03 14	20	Ebb	—	—	6,000
399	9.50	Upper bay by bell buoy N 12½	40 38 23	74 03 14	35	Ebb	—	—	5,300
400	10.08	Narrows, midway between Fort Lafayette and Fort Wadsworth	40 36 25	74 02 48	1	Ebb	—	—	9,000
401	10.09	Narrows, midway between Fort Lafayette and Fort Wadsworth	40 36 25	74 02 48	10	Ebb	—	—	8,000
402	10.10	Narrows, midway between Fort Lafayette and Fort Wadsworth	40 36 25	74 02 48	20	Ebb	—	—	5,500
403	10.12	Narrows, midway between Fort Lafayette and Fort Wadsworth	40 36 25	74 02 48	40	Ebb	—	—	5,000
404	10.25	Lower bay, by bell buoy Craven Shoal	40 35 08	74 02 32	1	Ebb	—	—	8,500
405	10.26	Lower bay, by bell buoy Craven Shoal	40 35 08	74 02 32	10	Ebb	—	—	6,800
406	10.27	Lower bay, by bell buoy Craven Shoal	40 35 08	74 02 32	20	Ebb	—	—	6,300
407	10.30	Lower bay, by bell buoy Craven Shoal	40 35 08	74 02 32	40	Ebb	—	—	3,200
408	10.50	Lower bay, by bell buoy A. C. 24, in Ambrose channel	40 33 30	74 01 25	1	Ebb	—	—	6,400
409	10.51	Lower bay, by bell buoy A. C. 24, in Ambrose channel	40 33 30	74 01 25	10	Ebb	—	—	5,300
410	10.53	Lower bay, by bell buoy A. C. 24, in Ambrose channel	40 33 30	74 01 25	20	Ebb	—	—	1,800
411	10.55	Lower bay, by bell buoy A. C. 24, in Ambrose channel	40 33 30	74 01 25	40	Ebb	—	—	600
412	11.10	Lower bay, by bell buoy A. C. 18, in Ambrose channel	40 32 00	74 00 50	1	Flood	—	—	5,300
413	11.12	Lower bay, by bell buoy A. C. 18, in Ambrose channel	40 32 00	74 00 50	10	Flood	—	—	3,100
414	11.14	Lower bay, by bell buoy A. C. 18, in Ambrose channel	40 32 00	74 00 50	20	Flood	—	—	1,200
415	11.16	Lower bay, by bell buoy A. C. 18, in Ambrose channel	40 32 00	74 00 50	40	Flood	—	—	640
416	11.35	Lower bay, by bell buoy A. C. 12, in Ambrose channel	40 31 05	73 59 10	1	Flood	—	—	840
417	11.36	Lower bay, by bell buoy A. C. 12, in Ambrose channel	40 31 05	73 59 10	10	Flood	—	—	260
418	11.38	Lower bay, by bell buoy A. C. 12, in Ambrose channel	40 31 05	73 59 10	20	Flood	—	—	360
419	11.40	Lower bay, by bell buoy A. C. 12, in Ambrose channel	40 31 05	73 59 10	40	Flood	—	—	160
420	12.30	Lower bay, by gas buoy A. C. E. 2, outer end Ambrose channel	40 29 50	73 56 15	1	Flood	—	—	500
421	12.32	Lower bay, by gas buoy A. C. E. 2, outer end Ambrose channel	40 29 50	73 56 15	10	Flood	—	—	460
422	12.34	Lower bay, by gas buoy A. C. E. 2, outer end Ambrose channel	40 29 50	73 56 15	20	Flood	—	—	400

TABLE XV—Continued

15—UPPER BAY, LOWER BAY AND ATLANTIC OCEAN. MAY 13, 1909—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
423	12.36	Lower bay, by gas buoy A. C. E. 2, outer end Ambrose channel..................	40 29 50	73 56 15	40	Flood	—	—	220
424	1.10	Atlantic ocean, by whistling buoy.........	40 28 45	73 53 35	1	Flood	—	—	600
425	1.12	Atlantic ocean, by whistling buoy.........	40 28 45	73 53 35	10	Flood	—	—	200
426	1.14	Atlantic ocean, by whistling buoy.........	40 28 45	73 53 35	20	Flood	—	—	340
427	1.16	Atlantic ocean, by whistling buoy.........	40 28 45	73 53 35	40	Flood	—	—	110

16—LOWER BAY. MAY 17, 1909

Low water occurred at Governors Island at 12.35 P. M. The wind was southeast with a velocity of from 30 to 40 miles per hour.

428	12.30	At gas buoy, S. 2, near Coney Island shore	40 34 02	73 59 20	1	Ebb	—	—	4,600
429	12.32	At gas buoy S. 2, near Coney Island shore	40 34 02	73 59 20	10	Ebb	—	—	3,600
430	12.35	At gas buoy S. 2, near Coney Island shore	40 34 02	73 59 20	20	Ebb	—	—	1,900
431	1.04	About ½ mile from buoy S. 2, on line.....	40 33 30	73 59 05	1	Slack	—	—	3,800
432	1.07	About ½ mile from buoy S. 2, on line.....	40 33 30	73 59 05	10	Slack	—	—	2,900
433	1.10	About ½ mile from buoy S. 2, on line.....	40 33 30	73 59 05	15	Slack	—	—	2,800
434	1.21	About ½ mile from buoy S. 2, on line.....	40 33 05	73 58 45	1	Flood	—	—	3,200
435	1.23	About ½ mile from buoy S. 2, on line.....	40 33 05	73 58 45	10	Flood	—	—	2,600
436	1.25	About ½ mile from buoy S. 2, on line.....	40 33 05	73 58 45	20	Flood	—	—	1,600
437	2.00	About ½ mile farther on line.............	40 32 40	73 58 45	1	Flood	—	—	2,200
438	2.02	About ½ mile farther on line.............	40 32 40	73 58 45	10	Flood	—	—	1,600
439	2.05	About ½ mile farther on line.............	40 32 40	73 58 45	16	Flood	—	—	1,200
440	2.31	About ½ mile farther on line.............	40 32 20	73 58 20	1	Flood	—	—	2,400
441	2.33	About ½ mile farther on line.............	40 32 20	73 58 20	10	Flood	—	—	1,700
442	2.35	About ½ mile farther on line.............	40 32 20	73 58 20	20	Flood	—	—	1,200
443	3.11	About ½ mile farther on line.............	40 31 50	73 58 15	1	Flood	—	—	2,100
444	3.13	About ½ mile farther on line.............	40 31 50	73 58 15	10	Flood	—	—	1,800
445	3.15	About ½ mile farther on line.............	40 31 50	73 58 15	20	Flood	—	—	1,000
446	3.35	About 1000 feet northwest of buoy A. C. 12, on line............................	40 29 50	73 56 35	1	Flood	—	—	1,800
447	3.37	About 1000 feet northwest of buoy A. C. 12, on line............................	40 29 50	73 56 35	10	Flood	—	—	1,200
448	3.40	About 1000 feet northwest of buoy A. C. 12, on line............................	40 29 50	73 56 35	20	Flood	—	—	800
449	4.00	50 feet north of buoy A. C. 12...........	40 29 50	73 56 25	1	Flood	—	—	1,400
450	4.02	50 feet north of buoy A. C. 12...........	40 29 50	73 56 25	10	Flood	—	—	1,100
451	4.05	50 feet north of buoy A. C. 12...........	40 29 50	73 56 25	16	Flood	—	—	900

17—LOWER BAY. MAY 18, 1909

Low water occurred at Governors Island at 1.22 P. M. The wind was north until 1.29 P. M. with a velocity of from 5 to 10 miles per hour. From 1.49 P. M. the wind was southeast with a velocity of 10 miles per hour.

452	10.00	100 feet south of buoy A. C. 12, in Ambrose channel..................................	40 29 45	73 56 15	1	Ebb	—	—	780
453	10.02	100 feet south of buoy A. C. 12, in Ambrose channel..............................	40 29 45	73 56 15	10	Ebb	—	—	640
454	10.05	100 feet south of buoy A. C. 12, in Ambrose channel..............................	40 29 45	73 56 15	20	Ebb	—	—	400
455	10.07	100 feet south of buoy A. C. 12, in Ambrose channel..............................	40 29 45	73 56 15	40	Ebb	—	—	320
456	10.18	Midway between buoy A. C. 12 and buoy N. B. 2..............................	40 29 40	73 57 15	1	Ebb	—	—	520

TABLE XV—Continued

17—LOWER BAY. MAY 18, 1909—Continued

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
457	10.22	Midway between buoy A. C. 12 and buoy N. B. 2	40 29 40	73 57 15	10	Ebb	—	—	480
458	10.24	Midway between buoy A. C. 12 and buoy N. B. 2	40 29 40	73 57 15	20	Ebb	—	—	360
459	10.35	100 feet north of buoy N. B. 2, just outside Main Ship channel	40 29 25	73 58 30	1	Ebb	—	—	420
460	10.37	100 feet north of buoy N. B. 2, just outside Main Ship channel	40 29 25	73 58 30	10	Ebb	—	—	400
461	10.39	100 feet north of buoy N. B. 2, just outside Main Ship channel	40 29 25	73 58 30	20	Ebb	—	—	180
462	10.45	100 feet south of buoy N. B. 2, in Main Ship channel	40 29 20	73 58 25	1	Ebb	—	—	600
463	10.47	100 feet south of buoy N. B. 2, in Main Ship channel	40 29 20	73 58 25	10	Ebb	—	—	520
464	10.49	100 feet south of buoy N. B. 2, in Main Ship channel	40 29 20	73 58 25	20	Ebb	—	—	280
465	11.03	100 feet south of buoy N. 2½, in Main Ship channel	40 29 05	73 59 25	1	Ebb	—	—	820
466	11.05	100 feet south of buoy N. 2½, in Main Ship channel	40 29 05	73 59 25	10	Ebb	—	—	540
467	11.07	100 feet south of buoy N. 2½, in Main Ship channel	40 29 05	73 59 25	20	Ebb	—	—	350
468	11.16	100 feet south of buoy N. 4, in Main Ship channel	40 29 00	74 00 20	1	Ebb	—	—	700
469	11.18	100 feet south of buoy N. 4, in Main Ship channel	40 29 00	74 00 20	10	Ebb	—	—	460
470	11.20	100 feet south of buoy N. 4, in Main Ship channel	40 29 00	74 00 20	20	Ebb	—	—	360
471	11.31	100 feet south of buoy N. 6, in Main Ship channel	40 28 55	74 00 45	1	Ebb	—	—	820
472	11.33	100 feet south of buoy N. 6, in Main Ship channel	40 28 55	74 00 45	10	Ebb	—	—	750
473	11.35	100 feet south of buoy N. 6, in Main Ship channel	40 28 55	74 00 45	20	Ebb	—	—	220
474	11.55	100 feet south of buoy N. 8, in Main Ship channel	40 28 45	74 01 20	1	Ebb	—	—	620
475	11.57	100 feet south of buoy N. 8, in Main Ship channel	40 28 45	74 01 20	10	Ebb	—	—	600
476	12.00	100 feet south of buoy N. 8, in Main Ship channel	40 28 45	74 01 20	20	Ebb	—	—	560
477	12.45	100 feet south of buoy N. 10, in Main Ship channel	40 28 30	74 02 10	1	Ebb	—	—	820
478	12.47	100 feet south of buoy N. 10, in Main Ship channel	40 28 30	74 02 10	10	Ebb	—	—	800
479	12.50	100 feet south of buoy N. 10, in Main Ship channel	40 28 30	74 02 10	20	Ebb	—	—	540
480	1.25	100 feet south of buoy N. 12, in Main Ship channel	40 28 35	74 02 40	1	Slack	—	—	1,100
481	1.27	100 feet south of buoy N. 12, in Main Ship channel	40 28 35	74 02 40	10	Slack	—	—	700
482	1.29	100 feet south of buoy N. 12, in Main Ship channel	40 28 35	74 02 40	20	Slack	—	—	350
483	1.49	100 feet west of buoy N. C. 2, in Main Ship channel	40 29 05	74 02 45	1	Flood	—	—	1,200
484	1.52	100 feet west of buoy N. C. 2, in Main Ship channel	40 29 05	74 02 45	10	Flood	—	—	1,000
485	1.55	100 feet west of buoy N. C. 2, in Main Ship channel	40 29 05	74 02 45	20	Flood	—	—	800
486	2.10	100 feet west of buoy N. C. 4, in Main Ship channel	40 29 35	74 02 40	1	Flood	—	—	840

TABLE XV—Continued

17—LOWER BAY. MAY 18, 1909—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
487	2.12	100 feet west of buoy N. C. 4, in Main Ship channel	40 29 35	74 02 40	10	Flood	—	—	600
488	2.15	100 feet west of buoy N. C. 4, in Main Ship channel	40 29 35	74 02 40	20	Flood	—	—	520
489	2.35	100 feet west of buoy N. C. 6, in Main Ship channel	40 30 05	74 02 40	1	Flood	—	—	2,200
490	2.37	100 feet west of buoy N. C. 6, in Main Ship channel	40 30 05	74 02 40	10	Flood	—	—	1,200
491	2.40	100 feet west of buoy N. C. 6, in Main Ship channel	40 30 05	74 02 40	20	Flood	—	—	900
492	2.55	100 feet west of buoy N. C. 8, in Main Ship channel	40 30 40	74 02 35	1	Flood	—	—	1,800
493	2.57	100 feet west of buoy N. C. 8, in Main Ship channel	40 30 40	74 02 35	10	Flood	—	—	1,100
494	3.00	100 feet west of buoy N. C. 8, in Main Ship channel	40 30 40	74 02 35	20	Flood	—	—	700
495	3.10	100 feet west of buoy N., in Main Ship channel	40 31 15	74 02 30	1	Flood	—	—	1,400
496	3.12	100 feet west of buoy N., in Main Ship channel	40 31 15	74 02 30	10	Flood	—	—	1,100
497	3.15	100 feet west of buoy N., in Main Ship channel	40 31 15	74 02 30	20	Flood	—	—	800
498	3.25	100 feet east of buoy C. 9, in Main Ship channel	40 31 55	74 02 25	1	Flood	—	—	2,100
499	3.27	100 feet east of buoy C. 9, in Main Ship channel	40 31 55	74 02 25	10	Flood	—	—	1,800
500	3.30	100 feet east of buoy C. 9, in Main Ship channel	40 31 55	74 02 25	20	Flood	—	—	950
501	3.40	100 feet east of buoy C. 9½, in Main Ship channel	40 32 20	74 01 35	1	Flood	—	—	2,000
502	3.42	100 feet east of buoy C. 9½, in Main Ship channel	40 32 20	74 01 35	10	Flood	—	—	1,600
503	3.45	100 feet east of buoy C. 9½, in Main Ship channel	40 32 20	74 01 35	20	Flood	—	—	700
504	3.55	100 feet east of buoy C. 11, in Main Ship channel	40 34 00	74 02 30	1	Flood	—	—	3,600
505	3.57	100 feet east of buoy C. 11, in Main Ship channel	40 34 00	74 02 30	10	Flood	—	—	1,900
506	4.00	100 feet east of buoy C. 11, in Main Ship channel	40 34 00	74 02 30	20	Flood	—	—	1,500
507	4.10	100 feet east of bell buoy, Craven Shoal	40 35 10	74 02 25	1	Flood	—	—	3,800
508	4.12	100 feet east of bell buoy, Craven Shoal	40 35 10	74 02 25	10	Flood	—	—	3,200
509	4.15	100 feet east of bell buoy, Craven Shoal	40 35 10	74 02 25	20	Flood	—	—	2,100

18—LOWER BAY. MAY 19, 1909

Low water occurred at Governor's Island at 2.14 P. M. The wind was southeast with a velocity of 10 miles per hour.

510	9 30	500 feet west of bell buoy on Craven Shoal	40 35 10	74 02 40	1	Ebb	—	—	6,400
511	9.32	500 feet west of bell buoy on Craven Shoal	40 35 10	74 02 40	10	Ebb	—	—	4,600
512	9 35	500 feet west of bell buoy on Craven Shoal	40 35 10	74 02 40	20	Ebb	—	—	3,800
513	10.00	500 feet off South Beach Shore, Staten Island	40 35 00	74 03 15	1	Ebb	—	—	4,200
514	10 12	500 feet off South Beach Shore, Staten Island	40 35 00	74 03 15	10	Ebb	—	—	3,600
515	10.32	Off south shore of Staten Island	40 34 05	74 04 35	1	Ebb	—	—	3,200
516	10.35	Off south shore of Staten Island	40 34 05	74 04 35	10	Ebb	—	—	2,100
517	10.58	Off south shore of Staten Island	40 33 10	74 04 35	1	Ebb	—	—	2,400
518	11.00	Off south shore of Staten Island	40 33 10	74 04 35	10	Ebb	—	—	2,000

TABLE XV—Continued

18—LOWER BAY. MAY 19, 1909—Continued

Sample No.	Hour A. M.	Location of Samples: Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
			° ′ ″	° ′ ″					
519	11.22	Off south shore of Staten Island	40 32 40	74 05 10	1	Ebb	—	—	1,900
520	11.25	Off south shore of Staten Island	40 32 40	74 05 10	10	Ebb	—	—	1,200
521	11.42	Off south shore of Staten Island	40 32 00	74 05 25	1	Ebb	—	—	1,200
522	11.45	Off south shore of Staten Island	40 32 00	74 05 25	10	Ebb	—	—	1,000
523	12.10	Off south shore of Staten Island	40 31 05	74 05 45	1	Ebb	—	—	1,400
524	12.12	Off south shore of Staten Island	40 31 05	74 05 45	10	Ebb	—	—	1,100
525	12 54	100 feet north of Old Orchard Shoal light	40 30 45	74 05 55	1	Ebb	—	—	1,100
526	12.57	100 feet north of Old Orchard Shoal light	40 30 45	74 05 55	10	Ebb	—	—	700
527	1.16	100 feet north of northern cable buoy	40 30 05	74 06 15	1	Ebb	—	—	1,050
528	1.18	100 feet north of northern cable buoy	40 30 05	74 06 15	10	Ebb	—	—	800
529	1.20	100 feet north of northern cable buoy	40 30 05	74 06 15	20	Ebb	—	—	640
530	1.40	100 feet north of southern cable buoy	40 29 25	74 06 35	1	Ebb	—	—	1,200
531	1.42	100 feet north of southern cable buoy	40 29 25	74 06 35	10	Ebb	—	—	900
532	1.45	100 feet north of southern cable buoy	40 29 25	74 06 35	20	Ebb	—	—	840
533	1.57	200 feet south of buoy S 1 W., by wreck	40 28 35	74 06 45	1	Ebb	—	—	950
534	1.59	200 feet south of buoy S 1 W., by wreck	40 28 35	74 06 45	10	Ebb	—	—	800
535	2.01	200 feet south of buoy S 1 W., by wreck	40 28 35	74 06 45	20	Ebb	—	—	680
536	2.10	Midway between buoy S 1 W. and Point Comfort Beacon	40 27 55	74 07 00	1	Ebb	—	—	820
537	2.12	Midway between buoy S 1 W. and Point Comfort Beacon	40 27 55	74 07 00	7	Ebb	—	—	740
538	3.05	500 feet south of spar buoy 1½, off Seguine Point	40 30 10	74 10 05	1	Flood	—	—	1,100
539	3.07	500 feet south of spar buoy 1½, off Seguine Point	40 30 10	74 10 05	10	Flood	—	—	900
540	310	500 feet south of spar buoy 1½, off Seguine Point	40 30 10	74 10 05	16	Flood	—	—	760
541	3.15	500 feet south of spar buoy N, off Seguine Point	40 29 55	74 09 40	1	Flood	—	—	950
542	3.17	500 feet south of spar buoy N, off Seguine Point	40 29 55	74 09 40	10	Flood	—	—	640
543	3.20	500 feet south of spar buoy N, off Seguine Point	40 29 55	74 09 40	20	Flood	—	—	720

19—EAST RIVER. MAY 26, 1909

High water occurred at Governors Island at 1.21 P. M. The wind was southwest with a velocity of 5 miles per hour.

544	10.05	20 feet off dock, Lawrence Point, L. I.	40 47 25	73 54 31	1	Ebb	—	—	2,000
545	10.07	20 feet off dock, Lawrence Point, L. I.	40 47 25	73 54 31	10	Ebb	—	—	1,800
546	10.12	¼ way across East river from Lawrence Point	40 47 30	73 54 38	1	Ebb	—	—	1,500
547	10.14	¼ way across East river from Lawrence Point	40 47 30	73 54 38	10	Ebb	—	—	1,200
548	10.20	½ way across East river	40 47 37	73 54 39	1	Ebb	—	—	2,100
549	10.22	½ way across East river	40 47 37	73 54 39	10	Ebb	—	—	1,800
550	10.24	½ way across East river	40 47 37	73 54 39	20	Ebb	—	—	1,300
551	10.30	¾ way across East river from Lawrence Point	40 47 44	73 54 40	1	Ebb	—	—	2,200
552	10.32	¾ way across East river from Lawrence Point	40 47 44	73 54 40	10	Ebb	—	—	2,000
553	10.34	¾ way across East river from Lawrence Point	40 47 44	73 54 40	20	Ebb	—	—	1,800
554	10.40	20 feet off dock at Stony Point, Bronx	40 47 50	73 54 41	1	Ebb	—	—	2,500
555	10.42	20 feet off dock at Stony Point, Bronx	40 47 50	73 54 41	10	Ebb	—	—	2,200
556	10.44	20 feet off dock at Stony Point, Bronx	40 47 50	73 54 41	20	Ebb	—	—	1,700

TABLE XV—Continued

19—EAST RIVER. MAY 26, 1909—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
557	3.15	20 feet off dock at Lawrence Point L. I.	40 47 25	73 54 31	1	Flood	—	—	5,400
558	3.17	20 feet off dock at Lawrence Point, L. I.	40 47 25	73 54 31	10	Flood	—	—	4,800
559	3.20	¼ way across East river from Lawrence Point	40 47 30	73 54 38	1	Flood	—	—	6,000
560	3.22	¼ way across East river from Lawrence Point	40 47 30	73 54 38	10	Flood	—	—	4,200
561	3.26	½ way across East river	40 47 37	73 54 39	1	Flood	—	—	5,000
562	3.28	½ way across East river	40 47 37	73 54 39	10	Flood	—	—	4,300
563	3.30	½ way across East river	40 47 37	73 54 39	20	Flood	—	—	3,800
564	3.35	¾ way across East river from Lawrence Point	40 47 44	73 54 40	1	Flood	—	—	9,000
565	3.37	¾ way across East river from Lawrence Point	40 47 44	73 54 40	10	Flood	—	—	8,200
566	3.39	¾ way across East river from Lawrence Point	40 47 44	73 54 40	20	Flood	—	—	6,300
567	3.44	20 feet off dock at Stony Point	40 47 50	73 54 41	1	Flood	—	—	8,400
568	3.46	20 feet off dock at Stony Point	40 47 50	73 54 41	10	Flood	—	—	7,200
569	3.48	20 feet off dock at Stony Point	40 47 50	73 54 41	20	Flood	—	—	5,200

20—HARLEM RIVER. MAY 26, 1909

High water occurred at Governors Island at 1.21 P. M. The wind was southwest with a velocity of 5 miles per hour.

Sample No.	Hour P. M.	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
570	11.20	20 feet off dock 118th street, Harlem river.	40 47 43	73 55 48	1	Flood	—	—	15,000
571	11.22	20 feet off dock 118th street, Harlem river.	40 47 43	73 55 48	10	Flood	—	—	13,500
572	11.24	20 feet off dock 118th street, Harlem river.	40 47 43	73 55 48	20	Flood	—	—	11,000
573	11.30	Midstream, Harlem river	40 47 41	73 55 44	1	Flood	—	—	14,000
574	11.32	Midstream, Harlem river	40 47 41	73 55 44	10	Flood	—	—	12,000
575	11.34	Midstream, Harlem river	40 47 41	73 55 44	20	Flood	—	—	10,500
576	11.40	20 feet off dock on Randall Island, Harlem river	40 47 40	73 55 40	1	Flood	—	—	18,000
577	11.42	20 feet off dock on Randall Island, Harlem river	40 47 40	73 55 40	10	Flood	—	—	13,000
578	4.08	20 feet off dock foot 118th street, Harlem river	40 47 43	73 55 48	1	Ebb	—	—	9,000
579	4.07	20 feet off dock foot 118th street, Harlem river	40 47 43	73 55 48	10	Ebb	—	—	8,400
580	4.10	20 feet off dock foot 118th street, Harlem river	40 47 43	73 55 48	20	Ebb	—	—	6,800
581	4.12	Midstream, Harlem river	40 47 41	73 55 44	1	Ebb	—	—	8,600
582	4.14	Midstream, Harlem river	40 47 41	73 55 44	10	Ebb	—	—	7,900
583	4.15	Midstream, Harlem river	40 47 41	73 55 44	20	Ebb	—	—	5,300
584	4.18	20 feet off dock on Randall Island, Harlem river	40 47 40	73 55 40	1	Ebb	—	—	8,200
585	4.20	20 feet off dock on Randall Island, Harlem river	40 47 40	73 55 40	10	Ebb	—	—	7,400

21—CROSS-SECTION ROCKAWAY INLET. JUNE 29 AND JULY 1, 1909

High water occurred at Governors Island at 5.11 P. M. on June 29, 1909. Low water occurred at Governors Island at 12.35 P. M. on July 1, 1909. The wind was northwest with a velocity of 5 miles per hour on June 29th. On July 1 the wind was southwest with a velocity of 10 miles per hour.

Sample No.	Hour P. M.	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
586	12.50	50 feet off dock at Rockaway Point	40 34 05	73 53 50	1	Ebb	20.5	16	2,600
587	1.20	½ way across Rockaway Inlet	40 34 15	73 53 55	1	Ebb	20.5	16	2,800
588	1.40	West side of Rockaway Inlet, by gas buoy No. 2	40 34 20	73 54 05	1	Ebb	20.5	16	3,200

TABLE XV—Continued

21—CROSS-SECTION ROCKAWAY INLET. JUNE 29 AND JULY 1, 1909—Continued

Sample No.	Hour P. M.	Location of Samples: Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
			° ′ ″	° ′ ″					
589	2.45	50 feet off dock at Rockaway Point	40 34 05	73 53 50	1	Flood	19.0	8	1,400
590	3.05	½ way across Rockaway Inlet	40 34 15	73 53 55	1	Flood	19.0	8	1,100
591	3.25	West side of Rockaway Inlet, by gas buoy No. 2	40 34 20	73 54 05	1	Flood	19.0	8	1,200

22—BEACH CHANNEL, JAMAICA BAY. JUNE 29, 1909

High water occurred at Governors Island at 5.11 P. M. The wind was northwest with a velocity of 5 miles per hour.

592	2.15	100 feet off Belle Harbor dock, Beach channel	40 34 55	73 51 05	1	Flood	21.5	16	1,800
593	3.05	100 feet off dock at Seaside, Rockaway Beach	40 35 10	73 49 35	1	Flood	22.5	20	2,700
594	3.35	100 feet above drawbridge, Rockaway Beach, Hammels station	40 35 45	73 48 50	1	Flood	23.0	20	3,600
595	5.00	30 feet off dock at clubhouse, Bayswater avenue	40 36 30	73 46 15	1	Flood	23.0	24	3,200
596	5.20	At bridge head of bay at Edgemere	40 36 00	73 46 10	1	Flood	27.0	28	4,400

23—JAMAICA BAY. JUNE 30, 1909

Low water occurred at Governors Island at 11.55 A. M. The wind was northwest with a velocity of 5 miles per hour.

597	7.30	At bridge Norton's creek, Edgemere	40 36 00	73 46 10	1	Ebb	27.0	28	5,200
598	7.50	30 feet off dock foot of Bayswater avenue, Far Rockaway	40 36 15	73 46 10	1	Ebb	25.0	28	4,200
599	8.30	100 feet off shore in creek, near Arverne station	40 35 40	73 47 20	1	Ebb	27.0	28	240,000
600	9.50	1000 feet off shore in same creek	40 36 05	73 47 20	1	Ebb	25.0	28	12,000
601	10.20	Cross channel, near Arverne	40 35 50	73 48 25	1	Ebb	25.0	28	8,000
602	1.10	100 feet off foot Bannister avenue, Arverne	40 35 45	73 48 15	1	Slack	26.0	28	280,000
603	1.40	In creek near foot of Pleasant street, Arverne	40 35 35	73 48 25	1	Flood	27.0	28	22,000
604	2.20	In creek foot of Park avenue, Arverne	40 35 30	73 48 20	1	Flood	27.0	28	30,000
605	3.05	Near foot Pleasant street, Arverne	40 35 35	73 48 10	1	Flood	27.0	28	11,000

24—JAMAICA BAY. JULY 1, 1909

Low water occurred at Governors Island at 12.35 P. M. The wind was southwest with a velocity of 5 miles per hour.

606	8.25	At mouth Fresh creek	40 38 30	73 52 55	1	Ebb	25.0	28	17,000
607	9.10	½ way up Fresh creek	40 38 50	73 53 20	1	Ebb	25.0	28	12,000
608	9.50	Fresh creek, just below R.R. crossing	40 39 15	73 53 45	1	Ebb	25.5	28	16,000
609	10.45	At head of Second creek	40 39 05	73 53 00	1	Ebb	26.0	28	1,000,000
610	11.05	At mouth of Second creek	40 38 55	73 52 40	1	Ebb	25.5	28	800,000
611	11.35	Jamaica bay, 500 feet off mouth Second creek	40 38 35	73 52 25	1	Ebb	25.5	28	280,000
612	12.00	Jamaica bay, 500 feet off mouth of Fresh creek	40 38 25	73 52 30	1	Ebb	25.5	28	120,000
613	12.50	Jamaica bay, 500 feet off Sand bay shore	40 37 50	73 53 05	1	Ebb	25.0	20	22,000
614	1.20	Creek at Canarsie	40 38 15	73 54 00	1	Flood	25.0	20	19,000
615	1.45	Jamaica bay, 100 feet off landing Canarsie	40 37 40	73 53 15	1	Flood	24.0	20	12,000
616	2.05	Jamaica bay, 200 feet off bath pool, Bergen Beach	40 37 00	73 53 45	1	Flood	24.0	20	4,800

TABLE XV—Continued

25—HUDSON RIVER. JULY 7, 1909

High water occurred at Governors Island at 11.16 A. M. The wind was east with a velocity of 5 miles per hour.

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
617	11.40	100 feet off shore, Mt. St. Vincent........	40 54 50	73 54 41	1	Flood	20.5	64	6,500
618	12.00	100 feet off shore, Mt. St. Vincent........	40 54 50	73 54 41	8	Flood	20.5	64	6,000
619	12.20	200 feet off shore, Ludlow station.........	40 55 35	73 54 30	1	Flood	20.5	64	6,200
620	12.30	200 feet of shore, Ludlow station..........	40 55 35	73 54 30	10	Flood	20.5	64	5,800
621	12.50	200 feet off shore, Federal Sugar Refining Co., Yonkers.........................	40 55 47	73 54 25	1	Flood	20.5	64	8,500
622	1.00	200 feet off shore Federal Sugar Refining, Co., Yonkers.........................	40 55 47	73 54 25	10	Flood	20.5	64	10,000
623	1.20	200 feet off Recreation pier, Yonkers.....	40 56 15	73 54 20	1	Flood	21.0	64	20,000
624	1.30	200 feet off Recreation pier, Yonkers.....	40 56 15	73 54 20	20	Flood	21.0	64	18,000
625	3.20	100 feet off shore, Mt. St. Vincent........	40 54 50	73 54 41	1	Ebb	21.0	68	12,000
626	3.30	100 feet off shore, Mt. St. Vincent........	40 54 50	73 54 41	8	Ebb	21.0	68	10,500
627	3.50	200 feet off shore, Riverdale station.......	40 54 10	73 54 55	1	Ebb	21.0	68	10,000
628	4.00	200 feet off shore, Riverdale station.......	40 54 10	73 54 55	10	Ebb	21.0	68	9,500
629	4.20	200 feet off drawbridge, Spuyten Duyvil creek................................	40 52 50	73 55 25	1	Ebb	21.0	68	10,500
630	4.30	200 feet off drawbridge, Spuyten Duyvil creek................................	40 52 50	73 55 25	20	Ebb	21.0	68	8,500
631	4.50	200 feet off shore, Inwood station.........	40 52 20	73 55 50	1	Ebb	21.0	68	9,000
632	5.00	200 feet off shore, Inwood station.........	40 52 20	73 55 50	10	Ebb	21.0	68	9,500

26—GRAVESEND BAY AND CONEY ISLAND CREEK. JULY 9, 1909.

High water occurred at Governors Island at 1.01 P. M. The wind was southeast with a velocity of 5 miles per hour.

633	12.30	Gravesend bay, 200 feet off Marine basin..	40 36 10	74 00 50	1	Flood	20.5	12	3,600
634	1.00	Gravesend bay, 200 feet off Atlantic Yacht Club................................	40 35 35	74 00 00	1	Flood	20.5	12	3,800
635	1.30	Coney Island creek, at mouth.............	40 34 45	73 59 20	1	Flood	20.5	12	20,000
636	2.15	Coney Island creek, foot 12th street.......	40 34 55	73 58 55	1	Ebb	21.0	12	8,500
637	3.10	Coney Island creek, foot 17th street.......	40 34 55	73 59 05	1	Ebb	21.0	12	9,000
638	3.40	Gravesend bay, foot 22d street...........	40 34 50	73 59 35	1	Ebb	22.0	12	240,000
639	4.30	Gravesend bay, foot 24th street...........	40 34 45	73 59 40	1	Ebb	21.5	12	130,000
640	5.00	Gravesend bay, 200 feet off Atlantic Yacht Club................................	40 35 35	74 00 00	1	Ebb	20.5	12	8,000

27—GRAVESEND BAY. JULY 10, 1909

High water occurred at Governors Island at 2.09 P. M. The wind was southeast with a velocity of 5 miles per hour.

641	9.45	End of dock, Ulmer Park................	40 35 25	73 59 50	1	Flood	19.0	12	6,000
642	10.15	End of dock, Bay Yacht Club, Bath Beach.	40 36 10	74 00 55	1	Flood	19.0	12	4,500
643	10.40	500 feet off Avon Beach Hotel............	40 36 00	74 00 20	1	Flood	19.0	12	3,800
644	11.10	100 feet off dock, Fort Lowry Hotel......	40 35 50	74 00 10	1	Flood	19.0	12	3,500
645	11.50	Outer end of Marine basin...............	40 36 10	74 01 05	1	Flood	19.0	12	3,200
646	12.20	By breakwater north of Coney Island creek	40 35 00	73 59 30	1	Flood	19.0	12	5,800
647	1.05	Foot 22d street, Coney Island............	40 34 50	73 59 35	1	Flood	19.0	12	140,000

TABLE XV—Continued

28—SANDY HOOK BAY, SHREWSBURY RIVER AND LOWER BAY. JULY 13, 1909

High water occurred at Governors Island at 5.09 P. M. The wind was southeast with a velocity of 5 miles per hour.

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
648	11.40	Sandy Hook bay, near Shrewsbury	40 27 50	74 01 25	1	Flood	20.5	16	800
649	12.20	Shrewsbury river at Spermaceti Cove	40 24 55	73 59 35	1	Flood	22.0	28	1,100
650	1.15	Shrewsbury river at Highland Landing	40 23 50	73 58 45	1	Flood	23.0	28	2,400
651	2.05	Navesink river, near mouth	40 22 50	73 59 15	1	Flood	23.0	28	1,600
652	3.00	Shrewsbury river at Seabright	40 21 55	73 58 40	1	Flood	25.0	32	2,800
653	3.45	200 feet off shore, Sandy Hook bay	40 26 45	73 59 50	1	Flood	20.5	20	720
654	4.10	Off west point of Sandy Hook	40 28 35	74 01 25	1	Flood	20.5	20	840
655	4.20	Off west point of Sandy Hook	40 28 35	74 01 25	40	Flood	20.0	20	600

29—LOWER BAY. JULY 13, 1909

High water occurred at Governors Island at 5.09 P. M. The wind was southeast, with a velocity of 5 miles per hour.

656	4.35	Lower bay, Main Ship channel	40 28 45	74 01 25	1	Flood	20.5	16	900
657	4.40	Lower bay, Main Ship channel	40 28 45	74 01 25	40	Flood	20.0	16	750
658	5.00	Lower bay, Main Ship channel	40 29 50	74 01 00	1	Flood	20.5	16	1,100
659	5.10	Lower bay, Main Ship channel	40 29 50	74 01 00	40	Flood	20.0	16	540

30—LOWER BAY. JULY 14, 1909

Low water occurred at Governors Island at 11.50 A. M.

660	9.15	Near bell buoy off Sea Gate Inn	40 34 15	73 59 50	1	Ebb	19.5	16	5,400
661	9.35	Near bell buoy off Sea Gate Inn	40 34 05	73 59 50	1	Ebb	19.5	16	6,200
662	10.00	East bank	40 32 25	73 59 45	1	Ebb	19.5	16	5,800
663	10.30	500 feet from buoy A. C. 16 in 14 foot channel	40 31 50	74 00 25	1	Ebb	19.5	16	5,200
664	11.00	Romer shoal south of Ambrose channel	40 31 20	74 00 35	1	Ebb	19.5	16	4,800
665	11.15	Swash channel	40 30 40	74 00 50	1	Ebb	19.5	16	4,200
666	11.25	Swash channel	40 30 40	74 00 50	30	Ebb	19.0	16	2,400
667	11.55	Swash channel	40 31 20	74 02 15	1	Ebb	19.5	16	4,400
668	12.05	Swash channel	40 31 20	74 02 15	30	Ebb	19.0	16	3,100
669	1.00	Main Ship channel	40 31 20	74 02 30	1	Flood	19.5	16	3,900
670	1.10	Main Ship channel	40 31 20	74 02 30	40	Flood	19.0	16	2,600
671	2.00	500 feet west of West Bank light	40 32 15	74 02 45	1	Flood	19.5	16	4,600
672	2.50	Midway between West Bank light and Elm Tree Beacon	40 33 05	73 04 10	1	Flood	19.5	16	4,200
673	3.30	1000 feet off Elm Tree Beacon	40 33 45	74 05 30	1	Flood	20.0	16	4,800

31—HARLEM RIVER. JULY 15, 1909

Low water occurred at Governors Island at 12.46 P. M.

674	12.30	Midstream at East 109th street	40 47 23	73 56 07	1	Ebb	21.0	36	120,000
675	1.05	Midstream at 3d avenue bridge	40 48 25	73 55 58	1	Ebb	21.0	36	90,000
676	1.25	Midstream at 155th street	40 49 40	73 56 03	1	Ebb	21.0	36	32,000
677	1.50	Midstream at 207th street	40 51 46	73 54 54	1	Ebb	21.0	36	20,000
678	2.15	Midstream, 200 feet east of Spuyten Duyvil bridge	40 52 42	73 55 28	1	Ebb	21.0	36	12,000
679	3.30	Midstream, 200 feet east of Spuyten Duyvil bridge	40 52 42	73 55 28	1	Flood	21.0	64	4,200

TABLE XV—Continued

31—HARLEM RIVER. JULY 15, 1909—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
680	3.45	Midstream at 207th street Bridge..........	40 51 46	73 54 54	1	Flood	21.0	44	14,000
681	4.10	Midstream at 155th street Bridge..........	40 49 40	73 56 03	1	Flood	21.5	36	20,000
682	4.35	Midstream at 3d avenue Bridge..........	40 48 25	73 55 58	1	Flood	21.5	32	28,000
683	4.50	Midstream at East 109th street..........	40 47 23	73 56 07	1	Flood	21.0	32	60,000

32—UPPER BAY. JULY 16, 1909

Low water occurred at Governors Island at 1.25 P. M.

684	11.30	Midway between Battery and Governors Island..............................	40 41 50	74 01 00	1	Ebb	20.5	28	16,000
685	1.00	¾ mile north Robbins Reef, near buoy G. 2.	40 40 12	74 03 10	1	Ebb	20.5	28	12,000

33—THE NARROWS. JULY 16, 1909

Low water occurred at Governors Island at 1.25 P. M. The wind was southeast with a velocity of 10 miles per hour.

686	1.50	Narrows, midway between forts..........	40 36 25	74 02 48	1	Ebb	20.5	28	9,500
687	4.10	Narrows, midway between forts..........	40 36 25	74 02 48	1	Flood	20.0	20	5,200

34—UPPER BAY. JULY 16, 1909

Low water occurred at Governors Island at 1.25 P. M.

688	4.45	¾ mile north Robbins Reef, near buoy G. 2.	40 40 12	74 03 10	1	Flood	20.0	28	8,500
689	5.20	Midway between Battery and Governors Island..............................	40 41 50	74 01 00	1	Flood	20.0	28	11,000

35—KILL VAN KULL. JULY 17, 1909

Low water occurred at Governors Island at 2.19 P. M. The wind was east, with a velocity of 5 miles per hour.

690	9.30	Upper bay, off Tompkinsville.............	40 38 20	74 04 15	1	Ebb	21.0	28	8,000
691	10.10	Kill van Kull, west end..................	40 38 30	74 08 40	1	Ebb	21.0	28	5,200
692	10.35	Kill van Kull, off Port Richmond.........	40 38 35	74 08 00	1	Ebb	21.0	28	5,400
693	11.00	Bodine creek, near mouth................	40 38 20	74 07 35	1	Ebb	22.0	28	6,400

36—UPPER BAY. JULY 17, 1909

Low water occurred at Governors Island at 2.19 P. M. The wind was east with a velocity of 5 miles per hour.

694	11.25	At end of pier, foot of 65th street, Brooklyn	40 38 40	74 01 55	1	Ebb	21.0	28	120,000
695	11.45	By buoy off Governors bay..............	40 39 30	74 01 35	1	Ebb	21.0	28	90,000
696	12.00	Off Atlantic Docks......................	40 41 05	74 00 50	1	Ebb	21.0	28	26,000
697	12.15	500 feet northeast of Ellis Island..........	40 41 55	74 02 15	1	Ebb	21.0	28	22,000

TABLE XV—Continued

37—UPPER BAY, NARROWS AND LOWER BAY. JULY 20, 1909

High water occurred at Governors Island at 10.21 A. M.

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
698	11.45	Upper bay, just south of Governors Island.	40 40 55	74 01 35	1	Ebb	20.5	20	32,000
699	12.25	Upper bay, 500 feet east of Robbins Reef light	40 39 27	74 03 49	1	Ebb	20.5	20	18,000
700	12.45	Narrows, midway between forts	40 36 25	74 02 48	1	Ebb	20.0	20	16,000
701	2.50	Lower bay, 500 feet off Nortons Point	40 34 35	74 00 50	1	Ebb	20.0	16	8,600

38—LOWER BAY. JULY 21, 1909

High water occurred at Governors Island at 11.01 A. M.

702	8.10	Lower bay, 500 feet off Nortons Point	40 34 35	74 00 50	1	Flood	19.0	12	3,200
703	8.15	Lower bay, 500 feet off Nortons Point	40 34 35	74 00 50	20	Flood	19.0	12	1,400
704	9.15	Lower bay, Ambrose channel buoy No. 5	40 30 15	73 57 40	1	Flood	19.0	8	480
705	9.20	Lower bay, Ambrose channel buoy No. 5	40 30 15	73 57 40	40	Flood	19.0	8	240

39—ATLANTIC OCEAN. JULY 21, 1909

High water occurred at Governors Island at 11.01 A. M. The wind was southeast with a velocity of 5 miles per hour.

	P. M.								
706	12.15	10 miles east of Long Branch, in mud gorge	40 19 15	73 48 45	1	Flood	19.0	—	220
707	12.20	10 miles east of Long Branch, in mud gorge	40 19 15	73 48 45	145	Flood	14.0	—	40
708	1.00	12 miles east of Long Branch, in mud gorge	40 19 15	73 47 15	1	Flood	19.0	—	180
709	1.20	12 miles east of Long Branch, in mud gorge	40 19 15	73 47 15	150	Flood	14.0	—	30
710	2.45	On "Oil Spot" off Sandy Hook	40 27 00	73 58 25	1	Ebb	19.0	4	440
711	3.00	On "Oil Spot" off Sandy Hook	40 27 05	73 58 25	1	Ebb	19.0	4	280
712	3.30	Off Sandy Hook, at bell buoy No. 5	40 28 45	73 59 50	1	Ebb	19.0	8	1,800
713	3.35	Off Sandy Hook, at bell buoy No. 5	40 28 45	73 59 50	40	Ebb	18.0	8	740

40—LOWER BAY. JULY 21, 1909

High water occurred at Governors Island at 11.01 A. M.

714	4.05	Lower bay, Ambrose channel buoy No. 10.	40 30 55	73 58 50	1	Ebb	19.0	12	3,200
715	4.10	Lower bay, Ambrose channel buoy No. 10.	40 30 55	73 58 50	40	Ebb	18.0	12	1,400

41—THE NARROWS. JULY 21, 1909

High water occurred at Governors Island at 11.01 A. M. The wind was southeast with a velocity of 5 miles per hour.

716	4.45	Narrows, midway between forts	40 36 25	74 02 48	1	Ebb	19.0	12	9,000
717	4.50	Narrows, midway between forts	40 36 25	74 12 48	40	Ebb	18.0	12	4,200

42—UPPER BAY. JULY 21, 1909

High water occurred at Governors Island at 11.01 A. M. The wind was southeast with a velocity of 5 miles per hour.

718	5.25	Upper bay, 1000 feet off Erie basin	40 40 20	74 01 20	1	Ebb	19.5	16	16,000
719	5.30	Upper bay, 1000 feet off Erie basin	40 40 20	74 01 20	20	Ebb	18.5	16	11,500

TABLE XV—Continued

43—HUDSON RIVER, UPPER BAY AND LOWER BAY. JULY 22, 1909

High water occurred at Governors Island at 11.51 A. M., and low water at 5.49 P. M. The wind was south with a velocity of 5 miles per hour.

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
720	10.20	Hudson river, midstream, off Gansevoort street	40 44 35	74 01 10	1	Flood	20.5	36	14,000
721	10.25	Hudson river, midstream, off Gansevoort street	40 44 35	74 01 10	60	Flood	19.0	36	6,400
722	10.45	Hudson river, midstream, off Desbrosses street	40 43 30	74 01 15	1	Flood	20.5	36	13,000
723	10.45	Hudson river, midstream, off Desbrosses street	40 43 30	74 01 15	40	Flood	20.0	36	7,000
724	11.20	Hudson river, midstream, off Pier A	40 42 19	74 01 34	1	Flood	20.5	32	10,500
725	11.25	Hudson river, midstream, off Pier A	40 42 19	74 01 34	40	Flood	20.0	32	6,000
726	11.40	Upper bay, 500 feet east of Liberty Island	40 41 20	74 02 25	1	Flood	20.0	28	8,600
727	11.48	Upper bay, 500 feet east of Liberty Island	40 41 20	74 02 25	50	Flood	19.5	28	4,200
728	12.10	Upper bay, near bell buoy G. 2	40 40 12	74 03 10	1	Flood	20.0	28	7,900
729	12.13	Upper bay, near bell buoy G. 2	40 40 12	74 03 10	50	Flood	19.5	28	3,700
730	12.25	Upper bay, near Robbins Reef bell buoy	40 39 10	74 03 50	1	Flood	20.0	20	8,000
731	12.30	Upper bay, near Robbins Reef bell buoy	40 39 10	74 03 50	60	Flood	19.5	20	3,700
732	12.50	Narrows, midway between forts	40 36 25	74 02 48	1	Flood	20.0	16	6,400
733	12.55	Narrows, midway between forts	40 36 25	74 02 48	90	Flood	19.0	16	3,600
734	1.15	Lower bay, 500 feet off Nortons Point	40 34 35	74 00 50	1	Flood	20.0	16	5,600
735	3.05	Narrows, midway between forts	40 36 25	74 02 48	1	Ebb	20.5	20	8,000
736	3.10	Narrows, midway between forts	40 36 25	74 02 48	90	Flood	19.0	20	4,200
737	3.30	Upper bay, near Robbins Reef bell buoy	40 39 10	74 03 50	1	Flood	20.5	28	10,500
738	3.37	Upper bay, near Robbins Reef bell buoy	40 39 10	74 03 50	60	Ebb	20.0	28	7,800
739	3.50	Upper bay, near bell buoy G. 2	40 40 12	74 03 10	1	Ebb	20.5	28	12,000
740	3.55	Upper bay, near bell buoy G. 2	40 40 12	74 03 10	50	Ebb	19.5	28	6,400
741	4.05	Upper bay, 500 feet east of Liberty Island	40 41 20	74 02 25	1	Ebb	20.5	28	16,000
742	4.10	Upper bay, 500 feet east of Liberty Island	40 41 20	74 02 25	50	Ebb	19.5	28	7,900
743	4.18	Hudson river, midstream, off Pier A	40 42 19	74 01 34	1	Ebb	20.5	32	14,000
744	4.21	Hudson river, midstream, off Pier A	40 42 19	74 01 34	40	Ebb	20.0	32	8,600
745	4.35	Hudson river, midstream, off Desbrosses street	40 43 30	74 01 15	1	Ebb	20.5	32	16,000
746	4.40	Hudson river, midstream, off Desbrosses street	40 43 30	74 01 15	40	Ebb	20.0	32	7,900
747	4.50	Hudson river, midstream, off Gansevoort street	40 44 35	74 01 10	1	Ebb	20.5	32	13,000
748	4.53	Hudson river, midstream, off Gansevoort street	40 44 35	74 01 10	60	Ebb	19.5	32	6,400

44—EAST RIVER. JULY 24, 1909

High water occurred at Governors Island at 12.51 P. M. The wind was north with a velocity of 30 miles per hour.

Sample No.	Hour A. M.	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
749	9.05	200 feet off east dock on Governors Island	40 41 35	74 00 50	1	Ebb	20.5	28	25,000
750	9.08	200 feet off east dock on Governors Island	40 41 35	74 00 50	40	Ebb	19.5	28	14,000
751	9.15	200 feet off Pier 38, Brooklyn	40 40 40	74 01 15	1	Ebb	20.5	28	42,000
752	9.18	200 feet off Pier 38, Brooklyn	40 40 40	74 01 15	40	Ebb	19.5	28	22,000
753	9.28	500 feet off Erie basin, in Upper bay	40 40 20	74 01 15	1	Ebb	20.5	28	21,000
754	9.30	500 feet off Erie basin, in Upper bay	40 40 20	74 01 15	30	Ebb	19.5	28	11,000
755	10.00	100 feet off Pier 10, Brooklyn	40 41 55	74 00 00	1	Ebb	20.5	28	22,000
756	10.05	100 feet off Pier 10, Brooklyn	40 41 55	74 00 00	40	Ebb	19.5	28	14,000
757	10.25	Foot of Oliver street, Manhattan pier head line	40 42 30	73 59 50	1	Ebb	21.5	28	124,000
758	10.30	Foot of Oliver street, Manhattan pier head line	40 42 30	73 59 50	20	Ebb	20.0	28	45,000
759	10.55	Foot of Corlears street, Manhattan	40 42 35	73 58 45	1	Ebb	20.5	28	11,000
760	11.00	Foot of Corlears street, Manhattan	40 42 35	73 58 45	20	Ebb	20.0	28	6,500

TABLE XV—Continued

45—HUDSON RIVER. JULY 26, 1909

High water occurred at Governors Island at 2.58 P. M. Ebb current ran down the river practically all day. The wind was north with a velocity of 10 miles per hour.

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
761	11.00	500 feet off Pier 4, Manhattan	40 42 25	74 01 10	1	Ebb	20.0	36	16,000
762	11.05	500 feet off Pier 4, Manhattan	40 42 25	74 01 10	40	Ebb	19.0	36	9,000
763	11.20	500 feet off foot West 23d street	40 45 09	74 00 45	1	Ebb	20.0	52	12,000
764	11.25	500 feet off foot West 23d street	40 45 09	74 00 45	40	Ebb	19.0	52	6,500
765	11.40	500 feet off foot West 59th street	40 46 25	73 59 45	1	Ebb	20.0	52	10,000
766	11.43	500 feet off foot West 59th street	40 46 25	73 59 45	40	Ebb	19.0	52	5,400
767	12.00	500 feet off foot West 96th street	40 47 50	73 58 40	1	Slack	20.0	52	22,000
768	12.05	500 feet off foot West 96th street	40 47 50	73 58 40	40	Slack	19.0	52	8,500
769	12.25	500 feet off foot of West 108th street	40 48 20	73 58 25	1	Slack	20.5	64	8,600
770	12.30	500 feet off foot of West 108th street	40 48 20	73 58 25	20	Slack	19.5	64	5,200
771	3.00	At foot of West 155th street, Washington Heights baths	40 50 00	73 57 05	1	Ebb	21.0	64	7,800
772	3.15	At foot of West 149th street, Manhattan baths	40 49 45	73 57 15	1	Ebb	21.0	64	8,400
773	3.25	At foot of West 136th street	40 49 20	73 57 20	1	Ebb	21.0	64	8,200

46—HUDSON RIVER. AUGUST 19, 1909

High water occurred at Governors Island at 10.42 A. M. The wind was north with a velocity of 5 miles per hour.

774	9.15	Midstream, opposite Pier 1, Manhattan	40 42 25	74 01 35	1	Flood	21.5	20	12,000
775	9.20	Midstream, opposite Pier 1, Manhattan	40 42 25	74 01 35	50	Flood	20.5	20	5,000
776	9.40	1000 feet off Pier 17, Manhattan	40 43 05	74 01 25	1	Flood	21.5	20	15,000
777	9.45	1000 feet off Pier 17, Manhattan	40 43 05	74 01 25	20	Flood	21.0	28	10,000
778	9.50	1000 feet off Pier 17, Manhattan	40 43 05	74 01 25	40	Flood	20.5	28	2,500
779	11.00	Midstream, opposite Pier 32, Manhattan	40 43 40	74 01 15	1	Flood	21.5	28	24,000
780	11.05	Midstream, opposite Pier 32, Manhattan	40 43 40	74 01 15	40	Flood	21.0	28	8,000
781	11.30	Midstream, opposite Pier 48, Manhattan	40 44 05	74 01 25	1	Flood	21.5	28	10,000
782	11.35	Midstream, opposite Pier 48, Manhattan	40 44 05	74 01 25	20	Flood	21.0	28	6,400
783	11.40	Midstream, opposite Pier 48, Manhattan	40 44 05	74 01 25	40	Flood	20.5	28	4,500

47—HUDSON RIVER. SEPTEMBER 7, 1909

High water occurred at Governors Island at 2.36 P. M. The wind was southeast with a velocity of 10 miles per hour.

784	10.20	500 feet off foot of West 42d street	40 45 45	74 00 15	1	Ebb	21.0	52	2,500
785	10.25	500 feet off foot of West 42d street	40 45 45	74 00 15	35	Ebb	20.5	52	3,000
786	10.55	500 feet off foot of West 72d street	40 46 55	73 59 25	1	Ebb	21.0	52	7,000
787	10.57	500 feet off foot of West 72d street	40 46 55	73 59 25	20	Ebb	20.5	52	8,400
788	11.00	500 feet off foot of West 72d street	40 46 55	73 59 25	35	Ebb	20.5	52	9,000
789	11.55	500 feet off foot of West 110th street	40 48 20	73 58 25	1	Flood	21.0	52	3,000
790	12.00	500 feet off foot of West 110th street	40 48 20	73 58 25	40	Flood	20.0	52	6,300
791	12.15	500 feet off foot of West 140th street	40 49 30	73 57 25	1	Flood	21.0	52	4,200
792	12.17	500 feet off foot of West 140th street	40 49 30	73 57 30	20	Flood	20.5	52	2,300
793	12.20	500 feet off foot of West 140th street	40 49 30	73 57 30	40	Flood	20.0	52	5,500
794	12.37	500 feet off Fort Washington Point	40 51 10	73 56 50	1	Flood	21.0	52	2,200
795	12.40	500 feet off Fort Washington Point	40 51 10	73 56 50	40	Flood	20.0	52	4,000
796	1.00	500 feet off Inwood bathing beach	40 52 20	73 55 55	1	Flood	21.0	52	2,100
797	1.02	500 feet off Inwood bathing beach	40 52 20	73 55 55	20	Flood	20.5	52	——
798	1.05	500 feet off Inwood bathing beach	40 52 20	73 55 55	40	Flood	20.0	52	2,800
799	1.20	500 feet off Spuyten Duyvil drawbridge	40 52 50	73 55 30	1	Flood	21.0	52	1,500

TABLE XV—Continued

47—HUDSON RIVER. SEPTEMBER 7, 1909—Continued

Sample No.	Hour P. M.	Location of Samples: Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
			° ′ ″	° ′ ″					
800	1.25	500 feet off Spuyten Duyvil drawbridge....	40 52 50	73 55 30	40	Flood	20.0	52	2,600
801	1.45	500 feet off Riverdale station............	40 54 15	73 55 00	1	Flood	21.0	52	2,500
802	1.48	500 feet off Riverdale station............	40 54 15	73 55 00	20	Flood	20.5	52	2,700
803	1.52	500 feet off Riverdale station............	40 54 15	73 55 00	40	Flood	20.0	52	600
804	2.15	500 feet off Federal refinery, Yonkers......	40 55 50	73 54 30	1	Flood	21.0	52	6,700
805	2.18	500 feet off Federal refinery, Yonkers.. ...	40 55 50	73 54 30	40	Flood	20.0	52	5,900
806	2.40	500 feet off power plant, northern end of Yonkers..........................	40 57 00	73 54 10	1	Flood	21.0	52	4,000
807	2.43	500 feet off power plant, northern end of Yonkers....	40 57 00	73 54 10	20	Flood	21.0	52	4,700
808	2.45	500 feet off power plant, northern end of Yonkers..........................	40 57 00	73 54 10	35	Flood	20.5	52	7,800

48—PASSAIC RIVER, NEWARK BAY AND KILL VAN KULL. SEPTEMBER 8, 1909

High water occurred at Governors Island at 3.21 P. M. The wind was southeast with a velocity of 10 miles per hour.

809	1.30	Passaic river, near foot of N. J. R.R. avenue, Newark............................	40 44 49	74 09 55	1	Flood	22.0	52	129,000
810	1.32	Passaic river, near foot of N. J. R.R. avenue, Newark............................	40 44 49	74 09 55	10	Flood	21.5	52	95,000
811	2.17	Passaic River 100 feet above P. R.R. freight bridge............................	40 44 10	74 09 45	1	Flood	21.5	40	216,000
812	2.20	Passaic river, 100 feet above P. R.R. freight bridge............................	40 44 10	74 09 45	10	Flood	21.0	40	106,000
813	2.40	Passaic river, near mouth................	40 43 15	74 07 20	1	Flood	21.0	40	12,000
814	2.43	Passaic river, near mouth................	40 43 15	74 07 20	10	Flood	20.5	40	46,000
815	3.00	Newark bay, near Lehigh Valley R.R.bridge	40 41 56	74 07 15	1	Flood	21.0	28	20,000
816	3.02	Newark bay, near Lehigh Valley R.R.bridge	40 41 56	74 07 15	10	Flood	20.5	28	25,000
817	3.23	Newark bay, near bell buoy off Centreville.	40 40 15	74 08 10	1	Flood	21.0	28	2,000
818	3.25	Newark bay, near bell buoy off Centreville.	40 40 15	74 08 10	10	Flood	20.5	28	1,700
819	3.40	Newark bay, near C. R.R. of N. J. drawbridge............................	40 39 17	74 08 46	1	Flood	20.5	28	10,000
820	342	Newark bay, near C. R.R. of N. J. drawbridge............................	40 39 17	74 08 46	15	Flood	20.5	28	6,000
821	3.45	Newark bay, near C. R.R. of N. J. drawbridge............................	40 39 17	74 08 46	30	Flood	20.0	28	8,000
822	4.00	Kill van Kull, west end..................	40 38 35	74 08 45	1	Flood	20.0	20	1,000
823	4.03	Kill van Kull, west end..................	40 38 35	74 08 45	35	Flood	20.0	20	1,500
824	4.25	Kill van Kull, opposite Sailors Snug Harbor	40 38 50	74 06 25	1	Flood	20.0	20	7,000
825	4.27	Kill van Kull, opposite Sailors Snug Harbor	40 38 50	74 06 25	20	Flood	20.0	20	4,500
826	4.30	Kill van Kull, opposite Sailors Snug Harbor	40 38 50	74 06 25	40	Flood	20.0	20	3,200
827	4.40	Kill van Kull, opposite Constable Hook..	40 39 05	74 05 15	1	Flood	20.0	20	2,000
828	4.43	Kill van Kull, opposite Constable Hook...	40 39 05	74 05 15	40	Flood	20.0	20	1,000

49—EAST RIVER. SEPTEMBER 9, 1909

Low water occurred at Governors Island at 10.38 A. M. The wind was southwest with a velocity of 5 miles per hour.

829	11.10	Off Battery, midstream..................	40 41 50	74 00 55	1	Ebb	20.0	32	5,000
830	11.12	Off Battery, midstream..................	40 41 50	74 00 55	20	Ebb	19.5	32	2,000
831	11.15	Off Battery, midstream..................	40 41 50	74 00 55	40	Ebb	19.0	32	1,000
832	11.35	At Brooklyn Bridge, midstream...........	40 42 20	73 59 48	1	Ebb	20.0	32	2,500
833	11.38	At Brooklyn Bridge, midstream...........	40 42 20	73 59 48	40	Ebb	19.0	32	1,800
834	11.54	At Williamsburg Bridge, midstream.......	40 42 49	73 58 21	1	Ebb	20.0	32	4,000

TABLE XV—Continued

49—EAST RIVER. SEPTEMBER 9, 1909—Continued

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
835	11.58	At Williamsburg Bridge, midstream	40 42 49	73 58 21	20	Ebb	19.5	32	2,000
836	12.00	At Williamsburg Bridge, midstream	40 42 49	73 58 21	40	Ebb	19.0	32	2,400
837	12.14	Off East 23d street, midstream	40 44 00	73 58 05	1	Ebb	20.0	32	2,800
838	12.17	Off East 23d street, midstream	40 44 00	73 58 05	40	Ebb	19.0	32	3,500
839	12.25	Off East 49th street, east channel	40 45 00	73 57 30	1	Flood	20.0	32	10,000
840	12.27	Off East 49th street, east channel	40 45 00	73 57 30	20	Flood	19.0	32	7,700
841	12.30	Off East 49th street, east channel	40 45 00	73 57 30	40	Flood	19.0	32	6,000
842	12.42	Off East 70th street, east channel	40 45 45	73 56 50	1	Flood	20.0	32	4,000
843	12.45	Off East 70th street, east channel	40 45 45	73 56 50	30	Flood	19.0	32	2,200
844	12.55	At Hell Gate	40 46 50	73 56 00	1	Flood	20.0	32	2,000
845	12.57	At Hell Gate	40 46 50	73 56 00	20	Flood	19.5	32	1,800
846	1.00	At Hell Gate	40 46 50	73 56 00	40	Flood	19.0	32	1,400
847	1.22	Between North and South Brother Islands	40 47 55	73 53 55	1	Flood	19.5	28	1,000
848	1.25	Between North and South Brother Islands	40 47 55	73 53 55	40	Flood	19.0	28	600
849	1.50	Off Clausons Point, midstream	40 48 00	73 50 40	1	Flood	19.0	28	1,500
850	1.55	Off Clausons Point, midstream	40 48 00	73 50 40	30	Flood	19.0	28	2,000
851	2.00	Off Clausons Point, midstream	40 48 00	73 50 40	70	Flood	18.5	28	1,200

50—LONG ISLAND SOUND. SEPTEMBER 9, 1909

Low water occurred at Governors Island at 10.38 A. M. The wind was southwest with a velocity of 5 miles per hour. The flood tide coming up Long Island Sound from the east meets the flood tide coming up the East river near the Stepping Stones light.

852	2.30	500 feet east of Throgs neck	40 48 20	73 47 20	1	Flood	19.0	28	400
853	2.33	500 feet east of Throgs neck	40 48 20	73 47 20	40	Flood	18.5	28	200
854	2.55	Near Stepping Stones light	40 49 30	73 46 30	1	Flood	19.0	28	120
855	2.57	Near Stepping Stones light	40 49 30	73 46 30	20	Flood	18.5	28	300
856	3.00	Near Stepping Stones light	40 49 30	73 46 30	40	Flood	18.5	28	150

51—EAST RIVER. SEPTEMBER 10, 1909

Low water occurred at Governors Island at 11.25 A. M. The wind was southeast with a velocity of 40 miles per hour.

857	9.55	Hell Gate, off East 90th street	40 46 30	73 56 30	1	Ebb	19.5	32	1,200
858	9.57	Hell Gate, off East 90th street	40 46 30	73 56 30	40	Ebb	19.0	32	1,500
859	10.10	East channel, off East 59th street	40 45 25	73 57 30	1	Ebb	19.5	32	9,000
860	10.12	East channel, off East 59th street	40 45 25	73 57 30	20	Ebb	19.0	32	9,000
861	10.15	East channel, off East 59th street	40 45 25	73 57 30	40	Ebb	19.0	32	7,200
862	10.25	Off East 34th street, midstream	40 44 25	73 58 00	1	Ebb	19.5	32	7,500
863	10.28	Off East 34th street, midstream	40 44 25	73 58 00	40	Ebb	19.0	32	6,000
864	10.35	At Williamsburg Bridge, midstream	40 42 49	73 58 21	1	Ebb	19.5	32	7,000
865	10.37	At Williamsburg Bridge, midstream	40 42 49	73 58 21	20	Ebb	19.0	32	3,300
866	10.40	At Williamsburg Bridge, midstream	40 42 49	73 58 21	40	Ebb	19.0	32	2,500
867	10.47	At Brooklyn Bridge, midstream	40 42 20	73 59 48	1	Ebb	19.5	32	6,500
868	10.50	At Brooklyn Bridge, midstream	40 42 20	73 59 48	40	Ebb	19.0	32	3,000
869	10.55	Off Battery, midstream	40 41 50	74 00 50	1	Ebb	19.5	32	8,000
870	10.56	Off Battery, midstream	40 41 50	74 00 50	20	Ebb	19.0	32	3,500
871	10.59	Off Battery, midstream	40 41 50	74 00 50	40	Ebb	19.0	32	3,500

TABLE XV—Continued

52—KILL VAN KULL. SEPTEMBER 11, 1909

Low water occurred at Governors Island at 12.25 P. M. The wind was northwest with a velocity of 40 miles per hour.

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
872	9.40	500 feet off St. George ferry in Upper bay..	40 38 55	74 04 50	1	Ebb	19.5	28	9,000
873	9.43	500 feet off St. George ferry in Upper bay..	40 38 55	74 04 50	40	Ebb	19.0	28	5,400
874	10.06	Off New Brighton station, midstream.....	40 38 57	74 05 25	1	Ebb	19.5	28	10,000
875	10.08	Off New Brighton station, midstream.....	40 38 57	74 05 25	20	Ebb	19.0	28	9,000
876	10.10	Off New Brighton station, midstream.....	40 38 57	74 05 25	40	Ebb	19.0	28	6,800
877	10.25	Off Sailors Snug Harbor, midstream.......	40 38 50	74 06 07	1	Ebb	19.5	28	12,000
878	10.28	Off Sailors Snug Harbor, midstream.......	40 38 50	74 06 07	40	Ebb	19.0	28	9,600
879	10.45	Off Port Richmond ferry, midstream......	40 38 35	74 07 52	1	Ebb	19.5	28	10,000
880	10.47	Off Port Richmond ferry, midstream......	40 38 35	74 07 52	20	Ebb	19.0	28	8,000
881	10.50	Off Port Richmond ferry, midstream......	40 38 35	74 07 52	30	Ebb	19.0	28	4,800
882	11.10	West end of Kill.........................	40 28 35	74 09 30	1	Ebb	19.5	28	8,400
883	11.12	West end of Kill.........................	40 28 35	74 09 30	30	Ebb	19.0	28	7,200

53—LOWER BAY. SEPTEMBER 13, 1909

Low water occurred at Governors Island at 1.53 P. M. The wind was southeast with a velocity of 5 miles per hour.

884	11.00	Near Ambrose channel buoy 24...........	40 33 30	74 01 25	1	Ebb	19.5	16	800
885	11.05	Near Ambrose channel buoy 24...........	40 33 30	74 01 25	20	Ebb	19.0	16	1,200
886	11.10	Near Ambrose channel buoy 24...........	40 33 30	74 01 25	35	Ebb	18.5	16	1,100
887	11.30	In Fourteen Foot channel near buoy A. C. 20	40 32 25	74 00 45	1	Ebb	19.5	16	2,000
888	11.35	In Fourteen Foot channel near buoy A. C. 20	40 32 25	74 00 45	25	Ebb	18.5	16	2,500
889	12.35	Between Ambrose and Fourteen Foot channels near buoy A. C. 10................	40 31 00	73 58 45	1	Ebb	19.5	16	1,500
890	12.40	Between Ambrose and Fourteen Foot channels near buoy A. C. 10................	40 31 00	73 58 45	20	Ebb	19.0	16	2,000
891	1.05	About 1000 feet north of buoy A. C. 4....	40 30 20	73 57 00	1	Ebb	20.0	16	1,400
892	1.10	About 1000 feet north of buoy A. C. 4....	40 30 20	73 57 00	20	Ebb	19.5	16	1,000
893	1.20	Near Ambrose channel buoy 4...........	40 30 10	73 56 55	1	Ebb	20.0	16	1,700
894	1.25	Near Ambrose channel buoy 4...........	40 30 10	73 56 55	35	Ebb	19.5	16	1,700
895	1.35	Near Ambrose channel buoy 3...........	40 29 55	73 57 05	1	Ebb	20.0	16	1,100
896	1.37	Near Ambrose channel buoy 3............	40 29 55	73 57 05	20	Ebb	19.5	16	900
897	1.47	100 feet north of Gedney channel buoy 6..	40 29 30	73 57 20	1	Flood	20.0	16	3,000
898	1.50	100 feet north of Gedney channel buoy 6..	40 39 30	73 57 20	30	Flood	19.0	16	1,400
899	2.10	Between Gedney channel buoys 6 and 5...	40 29 25	73 57 20	1	Flood	19.5	16	5,000
900	2.15	Between Gedney channel buoys 6 and 5...	40 29 25	73 57 20	35	Flood	18.5	16	4,500
901	2.25	200 feet south of Gedney channel buoy 5..	40 29 10	73 57 20	1	Flood	19.5	16	4,500
902	2.28	200 feet south of Gedney channel buoy 5..	40 29 10	73 57 20	28	Flood	19.0	16	2,400
903	2.40	100 feet south of buoy C. B. 1 off Sandy Hook	40 29 15	73 58 15	1	Flood	19.5	16	1,500
904	2.43	100 feet south of buoy C. B. 1 off Sandy Hook	40 29 15	73 58 15	30	Flood	19.0	16	1,600
905	2.55	500 feet southeast of buoy C. B. 3 off Sandy Hook................................	40 28 50	73 59 10	1	Flood	19.5	16	1,600
906	3.00	500 feet southeast of buoy C. B. 3 off Sandy Hook................................	40 28 50	73 59 10	35	Flood	19.0	16	1,500
907	3.30	1000 feet northeast of buoy N. 8..........	40 28 55	74 01 20	1	Flood	19.5	16	1,900
908	3.35	1000 feet northeast of buoy N. 8..........	40 28 55	74 01 20	15	Flood	18.5	16	2,700
909	3.55	500 feet southwest of buoy C. S. 1, near Swash channel........................	40 29 35	74 00 30	1	Flood	19.5	16	2,000
910	4.00	500 feet southwest of buoy C. S. 1, near Swash channel........................	40 29 35	74 00 30	35	Flood	18.5	16	2,500

TABLE XV—Continued

54—LOWER BAY. SEPTEMBER 14, 1909

Low water occurred at Governors Island at 2.38 P. M. The wind was southeast with a velocity of 10 miles per hour.

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
911	10.30	Main Ship channel, 200 feet east of West Bank light	40 32 20	74 02 30	1	Ebb	19.5	16	450
912	10.35	Main Ship channel, 200 feet east of West Bank light	40 32 20	74 02 30	35	Ebb	18.5	16	300
913	10.55	Swash channel, near Main Ship channel	40 31 25	74 02 20	1	Ebb	19.5	16	280
914	11.00	Swash channel, near Main Ship channel	40 31 25	74 02 20	30	Ebb	19.0	16	160
915	11.25	Swash channel, 300 feet northeast of buoy C. S. 3	40 30 50	74 01 45	1	Ebb	19.5	16	200
916	11.30	Swash channel, 300 feet northeast of buoy C. S. 3	40 30 50	74 01 45	20	Ebb	19.0	16	120
917	11.47	Swash channel, 500 feet south of Romer Shoals light	40 30 45	74 00 45	1	Ebb	19.5	16	150
918	11.50	Swash channel, 500 feet south of Romer Shoals light	40 30 45	74 00 45	30	Ebb	19.0	16	140
919	1.00	Swash channel, 500 feet south of buoy N. S. 4	40 30 00	73 59 45	1	Ebb	19.5	16	300
920	1.05	Swash channel, 500 feet south of buoy N. S. 4	40 30 00	73 59 45	30	Ebb	19.0	16	190
921	1.20	Swash channel, 500 feet north of buoy C. S. 1	40 29 45	74 00 30	1	Ebb	19.5	16	——
922	1.25	Swash channel, 500 feet north of buoy C. S. 1	40 29 45	74 00 30	25	Ebb	19.0	16	400
923	1.45	Romer Shoals, 500 feet northwest of buoy N. S. 2	40 29 50	73 59 20	1	Ebb	19.5	16	400
924	1.50	Romer Shoals, 500 feet northwest of buoy N. S. 2	40 29 50	73 59 20	25	Ebb	19.0	16	150
925	2.05	500 feet southeast of buoy A. C. 9, Ambrose channel	40 30 45	73 58 45	1	Ebb	19.5	16	270
926	2.10	500 feet southeast of buoy A. C. 9, Ambrose channel	40 30 45	73 58 45	20	Ebb	19.0	16	250
927	2.15	500 feet northwest of buoy A. C. 10, Ambrose channel	40 31 00	73 58 55	1	Ebb	19.5	16	200
928	2.20	500 feet northwest of buoy A. C. 10, Ambrose channel	40 31 00	73 58 55	25	Ebb	19.0	16	250
929	2.45	One-third of distance between buoy A. C. 8 and Manhattan Beach	40 32 05	73 57 40	1	Ebb	19.5	16	130
930	2.50	One-third of distance between buoy A. C. 8 and Manhattan Beach	40 32 05	73 57 40	20	Ebb	19.0	16	200
931	3.10	Two-thirds of distance between buoy A. C. 8 and Manhattan Beach	40 33 05	73 57 25	1	Ebb	19.5	16	560
932	3.15	Two-thirds of distance between buoy A. C. 8 and Manhattan Beach	40 33 05	73 57 25	22	Ebb	19.0	16	100

55—PASSAIC RIVER, NEWARK BAY AND KILL VAN KULL. SEPTEMBER 15, 1909

Low water occurred at Governors Island at 2.53 P. M. The wind was southeast with a velocity of 20 miles per hour.

933	12.40	Passaic river, near foot of N. J. R.R. avenue, Newark	40 44 49	74 09 55	1	Ebb	22.0	52	230,000
934	12.45	Passaic river, near foot of N. J. R.R. avenue, Newark	40 44 49	74 09 55	10	Ebb	21.5	52	160,000
935	1.05	Passaic river, near P. R.R. freight bridge below Newark	40 44 10	74 09 45	1	Ebb	22.0	52	90,000
936	1.08	Passaic river, near P. R.R. freight bridge below Newark	40 44 10	74 09 45	10	Ebb	21.5	52	40,000
937	1.25	Passaic river, near mouth	40 43 15	74 07 20	1	Ebb	21.0	52	32,000
938	1.30	Passaic river, near mouth	40 43 15	74 07 20	10	Ebb	20.5	52	17,000
939	1.45	Newark bay, near Lehigh Valley R.R. bridge	40 41 56	74 07 15	1	Ebb	20.0	32	24,000
940	1.50	Newark bay, near Lehigh Valley R.R. bridge	40 41 56	74 07 15	20	Ebb	19.5	32	18,000

TABLE XV—Continued

55—PASSAIC RIVER, NEWARK BAY AND KILL VAN KULL. SEPTEMBER 15, 1909—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
941	2.05	Newark bay, near bell buoy off Centreville.	40 40 15	74 08 10	1	Ebb	20.0	32	12,000
942	2.08	Newark bay, near bell buoy off Centreville.	40 41 15	74 08 10	20	Ebb	20.0	32	7,400
943	2.15	Newark bay, near C. R.R. of N. J. drawbridge.	40 39 17	74 08 46	1	Ebb	20.0	32	9,000
944	2.18	Newark bay, near C. R.R. of N. J. drawbridge.	40 39 17	74 08 46	20	Ebb	19.0	32	7,200
945	2.25	Kill van Kull, west end	40 38 35	74 08 45	1	Ebb	20.0	28	7,900
946	2.27	Kill van Kull, west end	40 38 35	74 08 45	20	Ebb	19.5	28	6,800
947	2.30	Kill van Kull, west end	40 38 35	74 08 45	35	Ebb	19.0	28	5,400
948	2.43	Kill van Kull, off Sailors Snug Harbor	40 38 50	74 06 25	1	Ebb	20.0	28	8,200
949	2.45	Kill van Kull, off Sailors Snug Harbor	40 38 50	74 38 50	30	Ebb	19.5	28	6,400
950	2.55	Kill van Kull, off Constable Hook	40 39 05	74 05 15	1	Ebb	20.0	28	6,800
951	2.37	Kill van Kull, off Constable Hook	40 39 05	74 05 15	20	Ebb	19.5	28	5,900
952	3.00	Kill van Kull, off Constable Hook	40 39 05	74 05 15	40	Ebb	19.0	28	4,800

56—ARTHUR KILL. SEPTEMBER 16, 1909

Low water occurred at Governors Island at 3.25 P. M. The wind was southeast with a velocity of 5 miles per hour.

Sample No.	Hour P. M.	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
953	11.55	Rahway river, ½ mile from mouth	40 35 55	74 12 45	1	Ebb	20.0	64	18,000
954	11.57	Rahway river, ½ mile from mouth	40 35 55	74 12 45	8	Ebb	19.5	64	50,000
955	12.25	Arthur Kills, opposite mouth of Rahway river	40 35 35	74 12 15	1	Ebb	20.0	28	23,000
956	12.30	Arthur Kills, opposite mouth of Rahway river	40 35 35	74 12 15	10	Ebb	19.5	28	20,000
957	1.05	Arthur Kills, off Fresh Kills	40 34 45	74 12 35	1	Ebb	20.0	28	8,000
958	1.10	Arthur Kills, off Fresh Kills	40 34 45	74 12 35	15	Ebb	19.5	28	2,000
959	1.20	Arthur Kills, near buoy S. A. off Smoking Point	40 33 30	74 13 40	1	Ebb	19.0	28	3,000
960	1.25	Arthur Kills, near buoy S. A. off Smoking Point	40 33 30	74 13 40	25	Ebb	18.5	28	2,400
961	2.00	Arthur Kills, near buoy S. 6, north of Rahway river	40 35 45	74 12 05	1	Ebb	19.5	28	8,000
962	2.05	Arthur Kills, near buoy S. 6, north of Rahway river	40 35 45	74 12 05	12	Ebb	19.5	28	5,000
963	2.35	Arthur Kills, 1000 feet west of Elizabethport drawbridge	40 38 10	74 11 55	1	Ebb	19.5	28	90,000
964	2.38	Arthur Kills, 1000 feet west of Elizabethport drawbridge	40 38 10	74 11 55	12	Ebb	19.0	28	32,000
965	2.50	Arthur Kills, 1000 feet east of Elizabethport drawbridge	40 38 20	74 11 45	1	Ebb	19.5	28	7,000
966	2.55	Arthur Kills, 1000 feet east of Elizabethport drawbridge	40 38 20	74 11 45	15	Ebb	19.0	28	3,000
967	3.05	Arthur Kills, near buoy S. 4 at east end	40 38 45	74 10 45	1	Ebb	19.5	28	3,200
968	3.07	Arthur Kills, near buoy S. 4 at east end	40 38 45	74 10 45	15	Ebb	19.0	28	4,600
969	3.17	Midway between Shooters Island and Mariners Harbor	40 28 35	74 09 30	1	Ebb	19.5	28	2,000
970	3.20	Midway between Shooters Island and Mariners Harbor	40 28 35	74 09 30	30	Ebb	19.0	28	4,500
971	3.35	West end of Kill van Kull	40 38 35	74 08 45	1	Ebb	19.5	28	7,000
972	3.40	West end of Kill van Kull	40 38 35	74 08 45	35	Ebb	19.0	28	6,000

TABLE XV—Continued

57—JAMAICA BAY. SEPTEMBER 17, 1909

Low water occurred at Governors Island at 4.25 P. M. The wind was northwest with a velocity of 5 miles per hour.

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
		Approximate	Latitude ° ′ ″	Longitude ° ′ ″					
973	10.40	Jamaica bay, near Dead Horse creek......	40 34 35	73 54 25	1	Ebb	19.5	20	4,000
974	10.45	Jamaica bay, near Dead Horse creek......	40 34 35	73 54 25	15	Ebb	19.0	20	7,200
975	11.00	Jamaica bay, 200 feet off Barren Island....	40 34 40	73 53 00	1	Ebb	19.5	20	3,500
976	11.05	Jamaica bay, 200 feet off Barren Island....	40 34 40	73 53 00	20	Ebb	19.0	20	1,600
977	11.25	Just south of Ruffle Bar.................	40 35 40	73 51 35	1	Ebb	19.5	20	4,400
978	11.30	Just south of Ruffle Bar.................	40 35 40	73 51 35	15	Ebb	19.0	20	3,100
979	11.50	About 1 mile off Canarsie breakwater.....	40 36 45	73 52 35	1	Ebb	19.5	20	6,100
980	11.55	About 1 mile off Canarsie breakwater.....	40 36 45	73 52 35	9	Ebb	19.0	20	3,600
981	12.10	200 feet off Canarsie light................	40 37 20	73 52 45	1	Ebb	19.5	20	8,000
982	12.12	200 feet off Canarsie light................	40 37 20	73 52 45	10	Ebb	19.5	20	3,100
983	1.05	200 feet off Canarsie light................	40 37 40	73 53 10	1	Ebb	19.5	20	3,900
984	1.08	200 feet off Canarsie light................	40 37 40	73 53 10	8	Ebb	19.5	20	3,900
985	2.00	1000 feet off mouth of Fresh creek........	40 38 20	73 52 15	1	Ebb	19.5	20	36,000
986	2.15	1000 feet off mouth of Second creek.......	40 38 30	73 52 15	1	Ebb	19.5	20	40,000
987	2.30	½ mile north of mouth of Second creek...	40 38 45	73 51 35	1	Ebb	19.5	20	5,200
988	3.00	1000 feet off shore at Sand bay...........	40 38 05	73 52 40	1	Ebb	19.5	20	16,000

58—HUDSON RIVER. SEPTEMBER 18, 1909

High water occurred at Governors Island at 10.34 A. M. The wind was southwest with a velocity of 10 miles per hour.

989	10.05	500 feet off C. R.R. of N. J. ferry, Communipaw................................	40 42 25	74 02 00	1	Flood	19.5	28	8,600
990	10.08	500 feet off C. R.R. of N. J. ferry, Communipaw................................	40 42 25	74 02 00	40	Flood	18.5	28	4,200
991	10.15	500 feet off P. R.R. ferry, Jersey City.....	40 43 00	74 01 55	1	Flood	19.5	28	9,600
992	10.17	500 feet off P. R.R. ferry, Jersey City.....	40 43 00	74 01 55	20	Flood	19.0	28	7,200
993	10.19	500 feet off P. R. R. ferry, Jersey City.....	40 43 00	74 01 55	40	Flood	18.5	28	5,300
994	10.35	500 feet off Lackawanna ferry, Hoboken...	40 43 40	74 01 50	1	Flood	19.5	28	12,000
995	10.38	500 feet off Lackawanna ferry, Hoboken...	40 43 40	74 01 50	40	Flood	18.5	28	6,800
996	10.50	500 feet off Stevens Point, Hoboken.......	40 44 40	74 01 20	1	Flood	19.5	28	8,400
997	10.52	500 feet off Stevens Point, Hoboken.......	40 44 40	74 01 20	20	Flood	19.0	28	7,900
998	10.55	500 feet off Stevens Point, Hoboken.......	40 44 40	74 01 20	40	Flood	18.5	28	4,800
999	11.25	500 feet off West Shore ferry, Weehawken.	40 46 45	74 00 20	1	Flood	19.5	28	7,200
1000	11.28	500 feet off West Shore ferry, Weehawken.	40 46 45	74 00 20	40	Flood	18.5	28	4,200

59—LOWER BAY. SEPTEMBER 20, 1909

Low water occurred at Governors Island at 5 25 P. M. The wind was southeast with a velocity of 40 miles per hour.

1001	11.55	500 feet southwest of West Bank light.....	40 32 10	74 02 40	1	Flood	19.0	8	5,500
1002	11.58	500 feet southwest of West Bank light.....	40 32 10	74 02 40	20	Flood	18.5	8	700
1003	12.20	About 1 mile from West Bank light on line with Port Monmouth..................	40 31 25	74 03 00	1	Flood	19.0	8	4,500
1004	12.22	About 1 mile from West Bank light on line with Port Monmouth..................	40 31 25	74 03 00	20	Flood	18.5	8	3,900
1005	1.00	Near white buoy S. on same line..........	40 30 20	73 05 15	1	Flood	19.0	8	2,900
1006	1.05	Near white buoy S. on same line..........	40 30 20	73 05 15	20	Flood	18.5	8	2,200
1007	1.20	Farther south on same line...............	40 29 35	74 03 25	1	Flood	19.0	8	2,500
1008	1.25	Farther south on same line...............	40 29 35	74 03 25	25	Flood	18.5	8	3,300
1009	1.40	Farther south on same line, near buoy C.C.1	40 28 35	74 03 15	1	Flood	19.0	8	3,000
1010	1.43	Farther south on same line, near buoy C.C.1	40 28 35	74 03 15	25	Flood	18.5	8	1,400

TABLE XV—Continued

59—LOWER BAY. SEPTEMBER 20, 1909—Continued

Sample No.	Hour A. M.	Location of Samples: Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
			° ' ''	° ' ''					
1011	2.00	Farther south on same line	40 27 40	74 02 40	1	Flood	19.0	8	750
1012	2.03	Farther south on same line	40 27 40	74 02 40	20	Flood	18.5	8	900
1013	2.20	About 1 mile off Atlantic Highlands	40 26 25	74 03 15	1	Flood	18.5	8	300
1014	2.23	About 1 mile off Atlantic Highlands	40 26 25	74 03 15	20	Flood	18.5	8	600
1015	2.40	About ½ mile off Atlantic Highlands	40 25 50	74 03 25	1	Ebb	19.0	8	800
1016	2.43	About ½ mile off Atlantic Highlands	40 25 50	74 03 25	18	Ebb	18.5	8	600
1017	3.40	About 2000 feet west of buoy S. 1 W. off Point Comfort	40 29 00	74 07 50	1	Ebb	19.0	8	500
1018	342	About 2000 feet west of buoy S. 1 W. off Point Comfort	40 29 00	74 07 50	12	Ebb	18.5	8	400
1019	4.00	Nearer Great Kills	40 29 50	74 07 40	1	Ebb	19.0	8	400
1020	4.02	Nearer Great Kills	40 29 50	74 07 40	25	Ebb	18.5	8	——
1021	4.20	1½ miles south of Great Kills	40 30 35	74 07 40	1	Ebb	19.0	8	300
1022	4.23	1½ miles south of Great Kills	40 30 35	74 07 40	15	Ebb	18.5	8	300
1023	4.32	1 mile south of Great Kills	40 31 10	74 07 45	1	Ebb	19.0	8	550
1024	4.35	1 mile south of Great Kills	40 31 10	74 07 45	10	Ebb	18.5	8	250

60—RARITAN BAY. SEPTEMBER 21, 1909

Low water occurred at Governors Island at 6.50 P. M. The wind was southeast with a velocity of 5 miles per hour.

1025	11.45	1000 feet east of buoy S. E. off Seguine Point	40 30 30	74 01 05	1	Flood	19.0	8	120
1026	11.47	1000 feet east of buoy S. E. off Seguine Point	40 30 30	74 01 05	20	Flood	18.5	8	110
1027	12.05	Near buoy S. 3, in Seguine channel	40 30 30	74 11 25	1	Flood	19.0	8	160
1028	12.07	Near buoy S. 3, in Seguine channel	40 30 30	74 11 25	25	Flood	18.5	8	160
1029	12.20	1000 feet southeast of Princes bay light	40 30 20	74 12 35	1	Flood	19.0	8	190
1030	12.22	1000 feet southeast of Princes bay light	40 30 20	74 12 35	20	Flood	18.5	8	——
1031	12.30	Near red buoy S. 6	40 29 45	74 13 35	1	Flood	19.0	8	120
1032	12.32	Near red buoy S. 6	40 29 45	74 13 35	25	Flood	18.5	8	200
1033	12.45	Near red buoy S. 8	40 29 05	74 14 20	1	Flood	19.0	8	150
1034	12.47	Near red buoy S. 8	40 29 05	74 14 20	25	Flood	18.5	8	320
1035	1.00	500 feet north of Great Beds light	40 29 15	74 15 15	1	Flood	19.0	8	220
1036	1.05	500 feet north of Great Beds light	40 29 15	74 15 15	16	Flood	18.5	8	410

61—ARTHUR KILL. SEPTEMBER 21, 1909

Low water occurred at Governors Island at 6.50 P. M. The wind was southeast with a velocity of 5 miles per hour.

1037	1.20	Lower end of Kills, 200 feet west of buoy S.	40 30 10	74 15 40	1	Flood	19.5	8	600
1038	1.25	Lower end of Kills, 200 feet west of buoy S.	40 30 10	74 15 40	30	Flood	18.5	8	200
1039	1.40	Off Tottenville, 200 feet west of buoy S. 2.	40 30 55	74 15 15	1	Flood	19.0	8	400
1040	1.45	Off Tottenville, 200 feet west of buoy S. 2.	40 30 55	74 15 15	45	Flood	18.0	8	600
1041	2.15	Off Smoking Point, 200 feet east of buoy S.A.	40 33 30	74 13 50	1	Flood	19.0	8	150
1042	2.17	Off Smoking Point, 200 feet east of buoy S.A.	40 33 30	74 13 50	30	Flood	18.5	8	——
1043	2.35	Off Fresh Kills	40 34 20	74 12 40	1	Flood	19.0	8	250
1044	2.40	Off Fresh Kills	40 34 20	74 12 40	28	Flood	18.5	8	250

TABLE XV—Continued

62—KILL VAN KULL, UPPER BAY AND EAST RIVER, SEPTEMBER 23, 1909

High water occurred at Governors Island at 2.14 P. M. The wind was southwest with a velocity of 10 miles per hour.

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
1045	11.10	West end of Kill van Kull, near buoy S. 2.	40 38 30	74 08 30	1	Flood	18.5	20	18,000
1046	11.12	West end of Kill van Kull, near buoy S. 2.	40 38 30	74 08 30	40	Flood	18.0	20	12,000
1047	11.30	Kill van Kull, off Livingston station	40 38 45	74 06 50	1	Flood	18.5	20	12,000
1048	11.32	Kill van Kull, off Livingston station	40 38 45	74 06 50	20	Flood	18.0	20	9,000
1049	11.35	Kill van Kull, off Livingston station	40 38 45	74 06 50	40	Flood	18.0	20	7,000
1050	12.20	East end of Kill van Kull, off Constable Hook	40 39 05	74 05 15	1	Flood	18.5	20	8,000
1051	12.25	East end of Kill van Kull, off Constable Hook	40 39 05	74 05 15	40	Flood	18.0	20	3,600
1052	12.50	Upper bay, near Robbins Reef bell buoy	40 39 15	74 03 50	1	Flood	18.5	20	6,400
1053	12.52	Upper bay, near Robbins Reef bell buoy	40 39 15	74 03 50	20	Flood	18.0	20	5,000
1054	12.55	Upper bay, near Robbins Reef bell buoy	40 39 15	74 03 50	40	Flood	18.0	20	3,800
1055	1.05	Upper bay, near buoy G. 2	40 40 10	74 03 12	1	Flood	18.5	20	5,400
1056	1.07	Upper bay, near buoy G. 2	40 40 10	74 03 12	40	Flood	18.0	20	——
1057	1.15	Upper bay, near buoy S. 2 off Liberty Island	40 41 05	74 02 40	1	Flood	18.5	20	9,000
1058	1.17	Upper bay, near buoy S. 2 off Liberty Island	40 41 05	74 02 40	20	Flood	18.0	20	8,400
1059	1.18	Upper bay, near buoy S. 2 off Liberty Island	40 41 05	74 02 40	40	Flood	18.0	20	4,500
1060	1.25	East river, between Governors Island and Battery	40 41 50	74 01 00	1	Flood	18.5	20	10,000
1061	1.27	East river, between Governors Island and Battery	40 41 50	74 01 00	40	Flood	18.0	20	7,200
1062	1.35	East river at Brooklyn Bridge, midstream.	40 42 20	73 59 48	1	Flood	18.5	20	12,000
1063	1.37	East river at Brooklyn Bridge, midstream.	40 42 20	73 59 48	20	Flood	18.0	20	——
1064	1.40	East river at Brooklyn Bridge, midstream.	40 42 20	73 59 48	40	Flood	18.0	20	6,400
1065	1.50	East river at Manhattan Bridge, midstream	40 42 25	73 59 25	1	Flood	18.5	20	12,000
1066	1.52	East river at Manhattan Bridge, midstream	40 42 25	73 59 25	40	Flood	18.0	20	8,600

63—UPPER BAY. SEPTEMBER 30, 1909

Low water occurred at Governors Island at 3.17 P. M. The wind was northwest with a velocity of 30 miles per hour.

1067	10.36	200 feet off Battery	40 42 10	74 01 10	1	Ebb	18.5	28	9,000
1068	10.38	200 feet off Battery	40 42 10	74 01 10	40	Ebb	18.0	28	3,600
1069	10.52	200 feet west of Governors Island	40 41 35	74 01 15	1	Ebb	18.5	28	4,200
1070	10.54	200 feet west of Governors Island	40 41 35	74 01 15	20	Ebb	18.0	28	3,000
1071	10.56	200 feet west of Governors Island	40 41 35	74 01 15	40	Ebb	18.0	28	2,500
1072	11.55	Near buoy G. 2	40 40 10	74 03 12	1	Ebb	18.5	28	6,400
1073	11.57	Near buoy G. 2	40 40 10	74 03 12	40	Ebb	18.0	28	2,800
1074	12.07	1000 feet west of Robbins Reef light	40 39 25	74 03 45	1	Ebb	18.5	28	4,800
1075	12.10	1000 feet west of Robbins Reef light	40 39 25	74 03 45	20	Ebb	18.0	28	3,500

64—KILL VAN KULL. SEPTEMBER 30, 1909

Low water occurred at Governors Island at 3.17 P. M. The wind was northwest with a velocity of 30 miles per hour

1076	12.20	East end of Kill	40 39 05	74 05 15	1	Ebb	18.5	28	4,500
1077	12.22	East end of Kill	40 39 05	74 05 15	20	Ebb	18.0	28	3,200
1078	12.25	East end of Kill	40 39 05	74 05 15	40	Ebb	18.0	28	3,000
1079	12.35	Off Sailors Snug Harbor	40 38 50	74 06 07	1	Ebb	18.5	28	5,200
1080	12.38	Off Sailors Snug Harbor	40 38 50	74 06 07	40	Ebb	18.0	28	2,800
1081	1.05	Off Port Richmond	40 38 35	74 07 52	1	Ebb	18.5	28	6,000
1082	1.07	Off Port Richmond	40 38 35	74 07 52	20	Ebb	18.0	28	3,500
1083	1.09	Off Port Richmond	40 38 35	74 07 52	40	Ebb	18.0	28	3,000
1084	2.40	West end of Kill	40 38 30	74 08 30	1	Ebb	18.5	28	6,200
1085	2.43	West end of Kill	40 38 30	74 08 30	40	Ebb	18.0	28	3,600

TABLE XV—Continued

65—EAST RIVER. OCTOBER 1, 1909

High water occurred at Governors Island at 9.21 A. M. The wind was northwest with a velocity of 40 miles per hour.

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
1086	9.50	500 feet off Pier 32, Brooklyn	40 41 10	74 00 30	1	Flood	18.0	28	5,400
1087	9.52	500 feet off Pier 32, Brooklyn	40 41 10	74 00 30	40	Flood	18.0	28	3,600
1088	10.00	At Brooklyn Bridge, 500 feet off Brooklyn shore	40 42 15	73 59 45	1	Flood	18.0	28	6,000
1089	10.02	At Brooklyn Bridge, 500 feet off Brooklyn shore	40 42 15	73 59 45	20	Flood	18.0	28	4,800
1090	10.04	At Brooklyn Bridge, 500 feet off Brooklyn shore	40 42 15	73 59 45	40	Flood	18.0	28	3,800
1091	10.16	At Williamsburg Bridge, 500 feet off Brooklyn shore	40 42 45	73 58 10	1	Flood	18.0	28	5,800
1092	10.18	At Williamsburg Bridge, 500 feet off Brooklyn shore	40 42 45	73 58 10	40	Flood	18.0	28	4,200
1093	10.30	Opposite East 34th street, 500 feet off Brooklyn shore	40 44 20	73 57 45	1	Flood	18.0	28	7,200
1094	10.31	Opposite East 34th street, 500 feet off Brooklyn shore	40 44 20	73 57 45	20	Flood	18.0	28	4,500
1095	10.33	Opposite East 34th street, 500 feet off Brooklyn shore	40 44 20	73 57 45	40	Flood	18.0	28	3,500
1096	10.50	At Queensboro Bridge, east channel	40 45 20	73 57 10	1	Flood	18.0	28	6,000
1097	10.52	At Queensboro Bridge, east channel	40 45 20	73 57 10	40	Flood	18.0	28	3,200
1098	11.05	At Hell Gate	40 46 50	73 56 00	1	Flood	18.0	28	4,800
1099	11.06	At Hell Gate	40 46 50	73 56 00	20	Flood	18.0	28	3,500
1100	11.08	At Hell Gate	40 46 50	73 56 00	40	Flood	18.0	28	2,000

66—LONG ISLAND SOUND. OCTOBER 1, 1909

Low water occurred at Governors Island at 4.05 P. M. The wind was northwest with a velocity of 40 miles per hour.

1101	1.20	Long Island Sound, near Throgs Neck	40 48 20	73 47 20	1	Ebb	18.0	28	1,300
1102	1.22	Long Island Sound, near Throgs Neck	40 48 20	73 47 20	25	Ebb	18.0	28	800
1103	1.24	Long Island Sound, near Throgs Neck	40 48 20	73 47 20	50	Ebb	18.0	28	600

67—EAST RIVER. OCTOBER 1, 1909

Low water occurred at Governors Island at 4.05 P. M. The wind was northwest with a velocity of 40 miles per hour.

1104	1.55	Between North and South Brothers Island	40 47 55	73 53 55	1	Ebb	18.0	28	2,000
1105	1.57	Between North and South Brothers Islands	40 47 55	73 53 55	40	Ebb	18.0	28	1,400

68—HARLEM RIVER. OCTOBER 1, 1909

Low water occurred at Governors Island at 4.05 P. M. The wind was northwest with a velocity of 40 miles per hour.

1106	2.13	Midstream, off East 116th street	40 47 35	73 55 50	1	Ebb	18.5	28	10,000
1107	2.15	Midstream, off East 116th street	40 47 35	73 55 50	20	Ebb	18.5	28	7,200
1108	2.25	Midstream, off East 110th street	40 47 20	73 56 05	1	Ebb	18.5	28	12,000
1109	2.27	Midstream, off East 110th street	40 47 20	73 56 05	20	Ebb	18.5	28	6,800

69—EAST RIVER. OCTOBER 1, 1909

Low water occurred at Governors Island at 4.05 P. M. The wind was northwest with a velocity of 40 miles per hour.

1110	2.35	Hell Gate, off East 90th street	40 46 40	73 56 20	1	Ebb	18.0	28	5,500
1111	2.36	Hell Gate, off East 90th street	40 46 40	73 56 20	20	Ebb	18.0	28	4,800
1112	2.38	Hell Gate, off East 90th street	40 46 40	73 56 20	40	Ebb	18.0	28	3,000
1113	2.47	At Queensboro Bridge, west channel	40 45 25	73 57 30	1	Ebb	18.0	28	4,800
1114	2.50	At Queensboro Bridge, west channel	40 45 25	73 57 30	40	Ebb	18.0	28	3,600

TABLE XV—Continued

69—EAST RIVER. OCTOBER 1, 1909—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	No. of Bacteria per C.C.
		Approximate	Latitude	Longitude					
			° ′ ″	° ′ ″					
1115	3.08	1000 feet off mouth of Newton creek	40 44 10	73 57 55	1	Ebb	18.5	28	9,000
1116	3.10	1000 feet off mouth of Newton creek	40 44 10	73 57 55	30	Ebb	18.0	28	6,800
1117	3.28	1000 feet off Wallabout bay	40 42 25	73 58 30	1	Ebb	18.5	28	8,600
1118	3.30	1000 feet off Wallabout bay	40 42 25	73 58 30	20	Ebb	18.0	28	7,000
1119	3.32	1000 feet off Wallabout bay	40 42 25	73 58 30	40	Ebb	18.0	28	4,800
1120	9.20	500 feet off Pier 4, Manhattan	40 42 00	74 00 40	1	Flood	17.0	28	5,100
1121	9.21	500 feet off Pier 4, Manhattan	40 42 00	74 00 40	20	Flood	17.0	28	4,200
1122	9.23	500 feet off Pier 4, Manhattan	40 42 00	74 00 40	40	Flood	17.0	28	3,200
1123	9.35	At Brooklyn Bridge, 500 feet off Manhattan shore	40 42 25	73 59 55	1	Flood	17.0	28	5,400
1124	9.37	At Brooklyn Bridge, 500 feet off Manhattan shore	40 42 25	73 59 55	40	Flood	17.0	28	3,800
1125	9.50	At Williamsburg Bridge, 500 feet off Manhattan shore	40 42 50	73 58 30	1	Flood	17.0	28	4,800
1126	9.52	At Williamsburg Bridge, 500 feet off Manhattan shore	40 42 50	73 58 30	20	Flood	17.0	28	5,200
1127	9.55	At Williamsburg Bridge, 500 feet off Manhattan shore	40 42 50	73 58 30	40	Flood	17.0	28	3,700
1128	10.15	Opposite East 34th street, 500 feet off shore	40 44 30	73 58 15	1	Flood	17.0	28	6,400
1129	10.18	Opposite East 34th street, 500 feet off shore	40 44 30	73 58 15	40	Flood	17.0	28	4,800
1130	10.30	At Queensboro Bridge, west channel	40 45 25	73 57 30	1	Flood	17.0	28	5,800
1131	10.31	At Queensboro Bridge, west channel	40 45 25	73 57 30	20	Flood	17.0	28	5,200
1132	10.33	At Queensboro Bridge, west channel	40 45 25	73 57 30	40	Flood	17.0	28	4,100
1133	10.40	Hell Gate, off East 90th street	40 46 30	73 56 20	1	Flood	17.0	28	4,500
1134	10.41	Hell Gate, off East 90th street	40 46 30	73 56 20	20	Flood	17.0	28	4,000
1135	10.43	Hell Gate, off East 90th street	40 46 30	73 56 20	40	Flood	17.0	28	3,600

70—HUDSON RIVER. OCTOBER 5, 1909

High water occurred at Governors Island at 1.00 P. M. The wind was northwest with a velocity of 10 miles per hour.

1136	10.55	1/5 way across from foot of West 42d street	40 45 50	74 00 20	1	Flood	17.0	52	3,200
1137	10.56	1/5 way across from foot of West 42d street	40 45 50	74 00 20	20	Flood	17.0	52	2,800
1138	10.57	1/5 way across from foot of West 42d street	40 45 50	74 00 20	40	Flood	17.0	52	2,100
1139	11.05	2/5 way across from foot of West 42d street	40 45 55	74 00 30	1	Flood	17.0	52	2,600
1140	11.07	2/5 way across from foot of West 42d street	40 45 55	74 00 30	20	Flood	17.0	52	2,200
1141	11.09	2/5 way across from foot of West 42d street	40 45 55	74 00 30	40	Flood	17.0	52	1,600
1142	11.15	3/4 way across from foot of West 42d street	40 46 00	74 00 50	1	Flood	17.0	52	2,000
1143	11.17	3/4 way across from foot of West 42d street	40 46 00	74 00 50	20	Flood	17.0	52	1,700
1144	11.19	3/4 way across from foot of West 42d street	40 46 00	74 00 50	40	Flood	17.0	52	1,200
1145	12.15	1/5 way across from foot of West 137th street	40 49 30	73 57 35	1	Flood	17.0	52	2,500
1146	12.16	1/5 way across from foot of West 137th street	40 49 30	73 57 35	20	Flood	17.0	52	2,000
1147	12.18	1/5 way across from foot of West 137th street	40 49 30	73 57 35	40	Flood	17.0	52	1,400
1148	12.28	2/5 way across from foot of West 137th street	40 49 35	73 57 50	1	Flood	17.0	52	2,200
1149	12.29	2/5 way across from foot of West 137th street	40 49 35	73 57 50	20	Flood	17.0	52	1,600
1150	12.30	2/5 way across from foot of West 137th street	40 49 35	73 57 50	40	Flood	17.0	52	1,000
1151	12.40	3/4 way across from foot of West 137th street	40 49 40	73 58 05	1	Flood	17.0	52	1,700
1152	12.41	3/4 way across from foot of West 137th street	40 49 40	73 58 05	20	Flood	17.0	52	1,500
1153	12.43	3/4 way across from foot of West 137th street	40 49 40	73 58 05	25	Flood	17.0	52	900
1154	1.20	500 feet off Inwood	40 52 20	73 55 55	1	Flood	17.0	52	1,600
1155	1.21	500 feet off Inwood	40 52 20	73 55 55	20	Flood	17.0	52	1,300
1156	1.23	500 feet off Inwood	40 52 20	73 55 55	40	Flood	17.0	52	900
1157	1.33	1/3 way across from Inwood	40 52 25	73 56 05	1	Flood	17.0	52	1,800
1158	1.34	1/3 way across from Inwood	40 52 25	73 56 05	20	Flood	17.0	52	1,200
1159	1.36	1/3 way across from Inwood	40 52 25	73 56 05	40	Flood	17.0	52	800
1160	1.46	3/4 way across from Inwood	40 52 35	73 56 25	1	Flood	17.0	52	1,400
1161	1.47	3/4 way across from Inwood	40 52 35	73 56 25	20	Flood	17.0	52	1,600
1162	1.49	3/4 way across from Inwood	40 52 35	73 56 25	25	Flood	17.0	52	700

INTRODUCTION TO TABLES XVI, XVII, XVIII, XIX, XX

The numbers of bacteria found in the water in the year 1909 and shown in Table XV have been grouped together in the form of averages to show (a) the numbers in various localities; (b) surface and bottom conditions and (c) the number on ebb and flood tides, and are contained in Table XIX.

The results used in making these averages are given in Tables XVI, XVII and XVIII. Table XX includes miscellaneous analyses not grouped elsewhere.

TABLE XVI

Average Number of Bacteria in the Water in the Year 1909

Averages for various parts of the harbor.

The data for this table are contained in Table XV.

Location	Number of Analyses	Bacteria per C. C.	Samples included in the Averages
Upper Bay	113	12,500	1–42, 303–305, 392–399, 684–685, 688–690, 696–699, 718–719, 726–731, 737–742, 749–754, 829–831, 869–873, 1052–1061, 1067–1075, 1086–1087. (694 and 695 taken at sewer outfall and 1056 liquefied, so not included.)
Hudson river, below Spuyten Duyvil	182	6,600	43–46, 264–302, 350–391, 619–620, 629–632, 720–725, 743–748, 761–796, 798–800, 989–1000, 1136–1162. (797 liquefied.)
Hudson river, above Spuyten Duyvil	53	5,100	229–263, 617–618, 801–808. (621–628, taken in sewage field from large Yonkers sewers, not included.)
East river, below Hell Gate	119	6,100	83–84, 127–166, 755–756, 759–760, 832–846, 857–868, 1062–1066, 1088–1100, 1110–1135. (757 and 758, taken at sewer outfall and 1063 liquefied, so not included.)
East river, above Hell Gate	37	3,100	81–82, 544–569, 847–853, 1104–1105.
Harlem river	58	15,600	201–228, 570–585, 674–683, 1106–1109.
Long Island Sound	40	310	47–80, 854–856, 1101–1103.
Kill van Kull	80	6,500	167–200, 691–692, 822–828, 874–883, 945–952, 969–970, 1045–1051, 1076–1085.
Newark bay	45	7,400	306–322, 335–349, 815–821, 939–944.
Passaic river, at Newark	8	92,000	327–330, 809–810, 933–934.
Arthur Kill	24	5,000	955–968, 971–972, 1037–1044. (963 and 964 taken at sewer outfall, so not included) (1042 liquefied.)
The Narrows	55	4,900	85–105, 106–126, 400–403, 686–687, 700–716, 717, 732–733, 735–736.
Gravesend Bay	15	4,300	633–634, 641–646. (635–640 and 647 taken in or near Coney Island creek, so not included.)
Lower bay	255	1,600	404–423, 428–543, 648–673, 701–705, 714–715, 884–932, 1001–1036. (921, 1020 and 1030 liquefied.)
Jamaica bay	39	8,400	592–598, 613, 615–616, 975–988. (599–612 and 614 taken in or near creeks, so not included.)
Rockaway inlet	8	2,900	586–591, 973–974.
Atlantic ocean, 10 miles off Long Branch	4	120	706–709

TABLE XVII

Average Number of Bacteria in the Water in the Year 1909

Average of samples taken near Surface and Bottom for various parts of the harbor.

The data for this table are contained in Table XV.

Location	Depths					
	Surface			Bottom		
	No. of Analyses	Bacteria per C. C.	Samples included in the Averages	No. of Analyses	Bacteria per C. C.	Samples included in the Averages
Upper bay	62	14,600	1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31, 33, 35, 42, 303, 392, 396, 684–685, 688–690, 696–699, 718, 726, 728, 730, 737, 739, 741, 749, 751, 753, 829, 869, 872, 1052, 1055, 1057, 1060, 1067, 1069, 1072, 1074, 1086. (694, taken at sewer outlet, not included.)	42	10,300	2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 305, 395, 399, 719, 727, 729, 731, 738, 740, 742, 750, 752, 754, 831, 871, 873, 1054, 1056, 1059, 1061, 1068, 1071, 1073, 1075, 1087. (697, taken at sewer outlet, not included.) (1056 liquefied.)
Hudson river, below Spuyten Duyvil	71	8,400	43–46, 264, 267, 270, 273, 276, 279, 282, 285, 288, 291, 294, 297, 300, 350, 354, 358, 362, 366, 369, 373, 377, 381, 385, 388, 619, 629, 631, 720, 722, 724, 743, 745, 747, 761, 763, 765, 767, 769, 771–773, 774, 776, 779, 781, 784, 786, 789, 791, 794, 796, 799, 989, 991, 994, 996, 999, 1136, 1139, 1142, 1145, 1148, 1151, 1154, 1157, 1160.	63	4,800	266, 269, 272, 275, 278, 281, 284, 287, 290, 293, 296, 299, 302, 353, 357, 361, 365, 368, 372, 376, 380, 384, 387, 391, 620, 630, 632, 721, 723, 725, 744, 746, 748, 762, 764, 766, 768, 770, 775, 778, 780, 783, 785, 788, 790, 793, 795, 798, 800, 990, 993, 995, 998, 1000, 1138, 1141, 1144, 1147, 1150, 1153, 1156, 1159, 1162.

TABLE XVII—Continued

Location	Depths					
	Surface			Bottom		
	No. of Analyses	Bacteria per C. C.	Samples included in the Averages	No. of Analyses	Bacteria per C. C.	Samples included in the Averages
Hudson river above Spuyten Duyvil..	15	6,300	229, 232, 235, 239, 243, 245, 248, 251, 255, 259, 261, 617, 801, 804, 806.	15	4,400	231, 234, 238, 242, 244, 247, 250, 254, 258, 260, 263, 618, 803, 805, 808.
East river, below Hell Gate........	41	7,700	83, 127, 131, 135, 139, 143, 147, 151, 155, 159, 163, 755, 832, 834, 837, 839, 842, 844, 857, 859, 862, 864, 867, 1062, 1065, 1088, 1091, 1093, 1096, 1098, 1110, 1113, 1115, 1117, 1120, 1123, 1125, 1128, 1130, 1133, 759. (757, taken at sewer outlet, not included.)	41	4,500	84, 130, 134, 138, 142, 146, 150, 154, 158, 162, 166, 756, 833, 836, 838, 841, 843, 846, 858, 861, 863, 866, 868, 1064, 1066, 1090, 1092, 1095, 1097, 1100, 1112, 1114, 1116, 1119, 1120, 1124, 1127, 1129, 1132, 1135, 760. (758, taken at sewer cutlet, not included.)
East river, above Hell Gate........	15	3,300	81, 544, 546, 548, 551, 554, 557, 559, 561, 564, 567, 847, 849, 852, 1104.	15	2,400	82, 545, 547, 550, 553, 556, 558, 560, 563, 566, 569, 848, 851, 853, 1105.
Harlem river.......	28	22,800	201, 203, 206, 209, 212, 215, 217, 220, 223, 226, 570, 573, 576, 578, 581, 584, 674, 683, 1106, 1108.	18	8,000	202, 205, 208, 211, 214, 216, 219, 222, 225, 228, 572, 575, 577, 580, 583, 585, 1107, 1109.
Long Island Sound..	19	410	47, 49, 51, 53, 55, 57, 59, 61, 63, 65, 67, 69, 71, 73, 75, 77, 79, 854, 1101	19	190	48, 50, 52, 54, 56, 58, 60, 62, 64, 68, 70, 72, 74, 76, 78, 80, 856, 1103.
Kill van Kull.......	30	8,100	167, 170, 174, 178, 182, 184, 187, 191, 195, 199, 691, 692, 822, 824, 827, 874, 877, 879, 882, 945, 948, 950, 969, 1045, 1047, 1050, 1076, 1079, 1081, 1084.	28	5,000	169, 173, 177, 181, 183, 186, 190, 194, 198, 200, 823, 826, 828, 876, 878, 881, 883, 947, 949, 952, 970, 1046, 1049, 1051, 1078, 1080, 1083, 1085.
Newark bay........	19	9,000	306, 308, 311, 313, 315, 317, 320, 335, 338, 341, 343, 346, 348, 815, 817, 819, 939, 941, 943.	19	6,300	307, 310, 312, 314, 316, 319, 322, 337, 340, 342, 345, 347, 349, 816, 818, 821, 940, 942, 944.
Passaic river, at Newark..........	4	111,000	327, 329, 809, 933.	4	75,000	328, 330, 810, 934.
Arthur Kill........	11	5,500	955, 957, 959, 961, 963, 965, 967, 971, 1037, 1039, 1041, 1043. (963, taken at sewer outlet, not included.)	10	4,400	956, 958, 960, 962, 964, 966, 968, 972, 1038, 1040, 1042, 1044. (964, taken at sewer outlet, not included.) (1042 liquefied.
The Narrows.......	17	8,300	85, 87, 92, 97, 102, 106, 108, 113, 118, 123, 400, 686, 687, 700, 716, 732, 735.	14	2,200	86, 91, 96, 101, 105, 107, 112, 117, 122, 126, 403, 717, 733, 736.
Gravesend bay.....	8	4,300	633–634, 641–646. (635-640 and 647, taken in or near Coney Island Creek, not included.)	..	....	No deep samples. Water shallow.
Lower bay.........	110	2,100	404, 408, 412, 416, 420, 428, 431, 434, 437, 440, 443, 446, 449, 452, 456, 459, 462, 465, 468, 471, 474, 477, 480, 483, 486, 489, 492, 495, 498, 501, 504, 507, 510, 513, 515, 517, 519, 521, 523, 525, 527, 530, 533, 536, 538, 541, 648–654, 656, 658, 660–665, 667, 669, 671–673, 701–702, 704, 714, 884, 887, 889, 891, 893, 895, 897, 899, 901, 903, 905, 907, 909, 911, 913, 915, 917, 919, 921–922, 924, 926, 928–929, 931, 1001, 1003, 1005, 1007, 1009, 1011, 1013, 1015, 1017, 1019, 1021, 1023, 1025, 1027, 1029, 1031, 1033, 1035. (921 liquefied.)	94	1,100	407, 411, 415, 419, 423, 430, 433, 436, 439, 442, 445, 448, 451, 455, 458, 461, 464, 467, 470, 473, 476, 479, 482, 485, 488, 491, 494, 497, 500, 503, 506, 509, 512, 514, 516, 518, 520, 522, 524, 526, 529, 532, 535, 537, 540, 543, 655, 657, 659, 666, 668, 670, 703, 705, 715, 886, 888, 890, 892, 894, 896, 898, 900, 902, 904, 906, 908, 910, 912, 914, 916, 918, 920, 923, 925, 927, 930, 932, 1002, 1004, 1006, 1008, 1010, 1012, 1014, 1016, 1018, 1020, 1022, 1024, 1026, 1028, 1030, 1032, 1034, 1036. (1020 and 1030 liquefied.)
Jamaica bay.......	19	9,900	592–598, 613, 615–616, 975, 977, 979, 981, 983, 985–988. (599–612 and 614, taken in or near creeks, which empty into bay, not included.)	..	....	Only 5 deep samples taken. Water shallow. (976, 978, 980, 982, 984 not enough for fair average.)
Rockaway inlet.....	7	2,300	586–591, 973.	..	....	Only 1 deep sample taken (974).
Atlantic ocean, 10 miles off Long Branch..........	2	200	706, 708.	2	35	707, 709.

TABLE XVIII

Average Number of **Bacteria in the Water** in the Year 1909

Averages of samples taken on Ebb and Flood Currents for various parts of the harbor.

The data for this table are contained in Table XV.

Location	Currents					
	Ebb Currents			Flood Currents		
	No. of Analyses	Bacteria per C. C.	Samples included in the Averages	No. of Analyses	Bacteria per C. C.	Samples included in the Averages
Upper bay	79	13,800	1–12, 23–42, 303–305, 392–399, 684–685, 696–699, 718–719, 737–742, 749–754, 829–831, 869–873, 1067–1075. (694–695, taken at sewer outlet, not included.)	31	9,300	13–22, 688–690, 726–731, 1052–1061, 1086–1087. (1056 liquefied.)
Hudson river, below Spuyten Duyvil	94	8,100	43–46, 264–302, 350–368, 388–391, 629–632, 743–748, 761–773, 784–788.	87	5,100	369–387, 619–620, 720–725, 774–783, 789–796, 798–800, 989–1000, 1136–1162. (797 liquefied).
Hudson river, above Spuyten Duyvil	35	5,200	229–244, 261–263. (625–628, taken in Yonkers sewage field, not included.)	10	4,700	245–260, 617–618, 801–808. (621–624, taken in Yonkers sewage field, not included.)
East river, below Hell Gate	55	6,700	83–84, 147–166, 755–756, 832–838, 857–868, 1110–1119, 759–760. (757–758, taken at sewer outlet, not included.)	61	5,600	127–146, 839–846, 1062–1066, 1088–1100, 1120–1135. (1063 liquefied.)
East river, above Hell Gate	17	1,800	81–82, 544–556, 1104–1105.	20	4,200	557-569, 847–853.
Harlem river	31	16,200	215–228, 578–585, 674–678, 1106–1109.	27	15,000	201–214, 570-577, 679–683.
Long Island sound	17	390	47–56, 77–80, 1101–1103.	23	250	57–76, 854–856.
Kill van Kull	49	6,900	184–200, 691–692, 874–883, 945–952, 969–970, 1076–1085.	31	6,000	167–183, 822–828, 1045–1051.
Newark bay	21	9,000	335–349, 939–944.	24	6,000	306–322, 815–821.
Passaic river, at Newark	4	121,000	329–330, 933–934.	4	65,000	327–328, 808–810.
Arthur Kill	14	7,300	955–962, 965–968, 971–972. (963–964, taken at sewer outlet, not included.)	7	350	1037–1041, 1043–1044. (1042 liquefied).
The Narrows	31	6,700	85–105, 400–403, 686, 700, 716–717, 735–736.	24	2,700	106–126, 687, 732–733.
Gravesend bay	..	....	(636–640, taken in or near Coney Island creek and outlet from disposal plant, not included.)	8	4,300	633–634, 641–646. (635 and 647, taken in Coney Island creek, not included.)
Lower bay	134	1,600	404–411, 428–433, 452–482, 510–537, 660–668, 701, 714–715, 884–896, 911–932, 1009–1024. (921 and 1020 liquefied.)	117	1,500	412–423, 434–451, 483–509, 538–543, 648–659, 669–673, 702–705, 897–910, 1001–1008, 1025–1036. (1030 liquefied.)
Jamaica bay	14	9,800	597–598, 975–988. (599–612, taken in creeks or near large sewer outlets, not included.)	10	6,400	592–596, 613, 615–616. (614, taken in creek, not included.)
Rockaway inlet	5	4,000	586–588, 973–974.	3	1,200	589–591.
Atlantic ocean, 10 miles off Long Branch	..	....	No samples taken on the ebb.	4	120	706–709.

TABLE XIX

Average Number of Bacteria in the Water in the Year 1909

Summary of Tables XVI, XVII and XVIII.

The data for this table are contained in Table XV.

Location	All Depths and Currents		Depths				Currents			
			Surface		Bottom		Ebb		Flood	
	No. of Analyses	Bacteria per C. C.	No. of Analyses	Bacteria per C. C.	No. of Analyses	Bacteria per C. C.	No. of Analyses	Bacteria per C. C.	No. of Analyses	Bacteria per C. C.
Upper bay	113	12,500	62	14,600	42	10,300	79	13,800	31	9,300
Hudson river, below Spuyten Duyvil	182	6,600	71	8,400	63	4,800	94	8,100	87	5,100
Hudson river, above Spuyten Duyvil	53	5,100	15	6,300	15	4,400	35	5,200	10	4,700
East river, below Hell Gate	119	6,100	14	7,700	41	4,500	55	6,700	61	5,600
East river, above Hell Gate	37	3,100	15	3,300	15	2,400	17	1,800	20	4,200
Harlem river	58	15,600	28	22,800	18	8,000	31	16,200	27	15,000
Long Island Sound	40	310	19	410	19	190	17	390	23	250
Kill van Kull	80	6,500	30	8,100	28	5,000	49	6,900	31	6,000
Newark bay	45	7,400	19	9,000	19	6,300	21	9,000	24	6,000
Passaic river, at Newark	8	92,000	4	111,000	4	75,000	4	121,000	4	65,000
Arthur Kill	24	5,000	11	5,500	10	4,400	14	7,300	7	350
The Narrows	55	4,900	17	8,300	14	2,200	31	6,700	24	2,700
Gravesend bay	15	4,300	8	4,300	....	....	....	....	8	4,300
Lower bay	255	1,600	110	2,100	94	1,100	134	1,600	117	1,500
Jamaica bay	39	8,400	19	9,900	....	....	14	9,800	10	6,400
Rockaway inlet	8	2,900	7	2,300	....	....	5	4,000	3	1,200
Atlantic ocean, 10 miles off Long Branch	4	120	2	200	2	35	....	....	4	120

TABLE XX

Average Number of Bacteria in the Water in the Year 1909

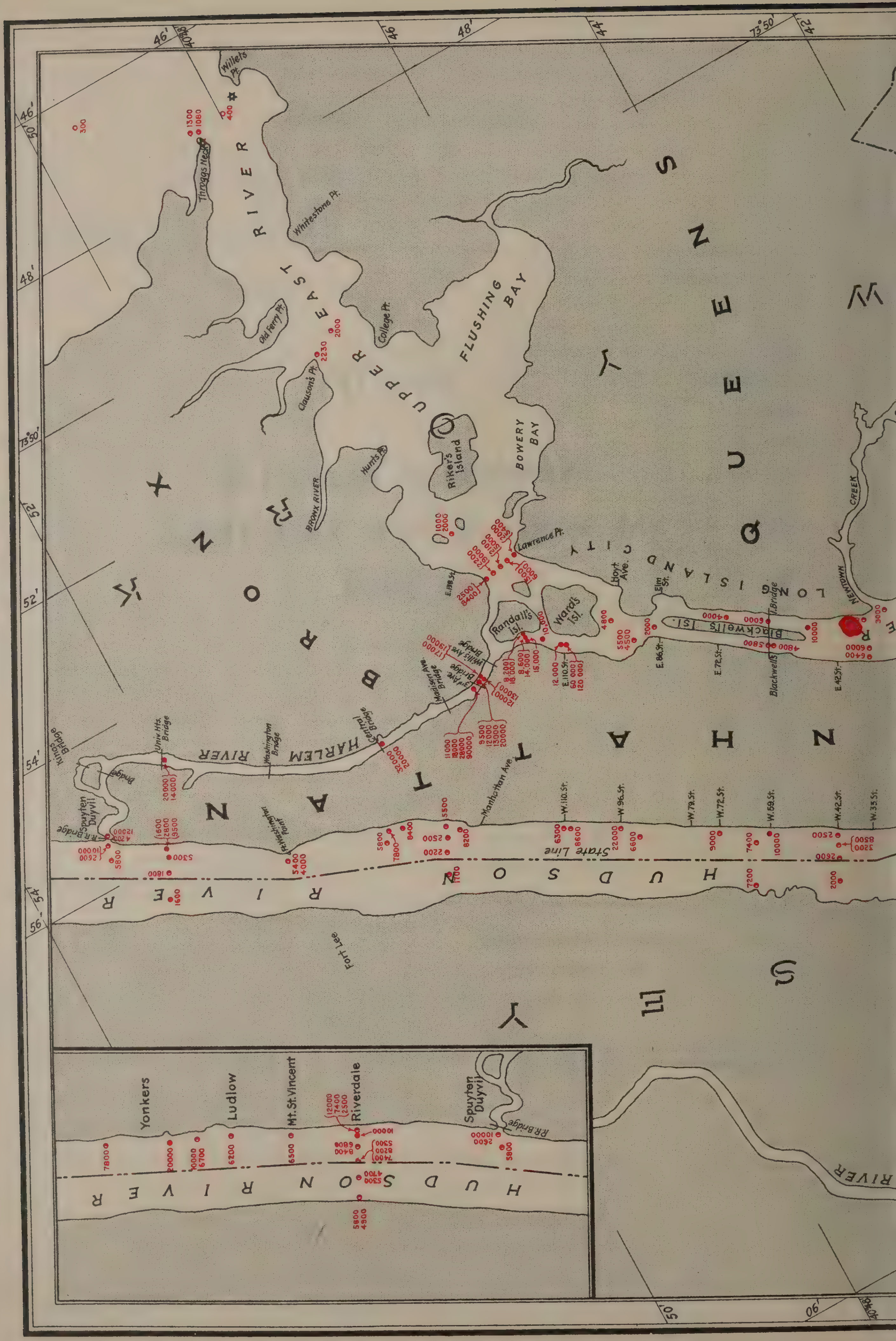
Averages of samples taken at miscellaneous locations in the harbor.

The data for this table are contained in Table XV.

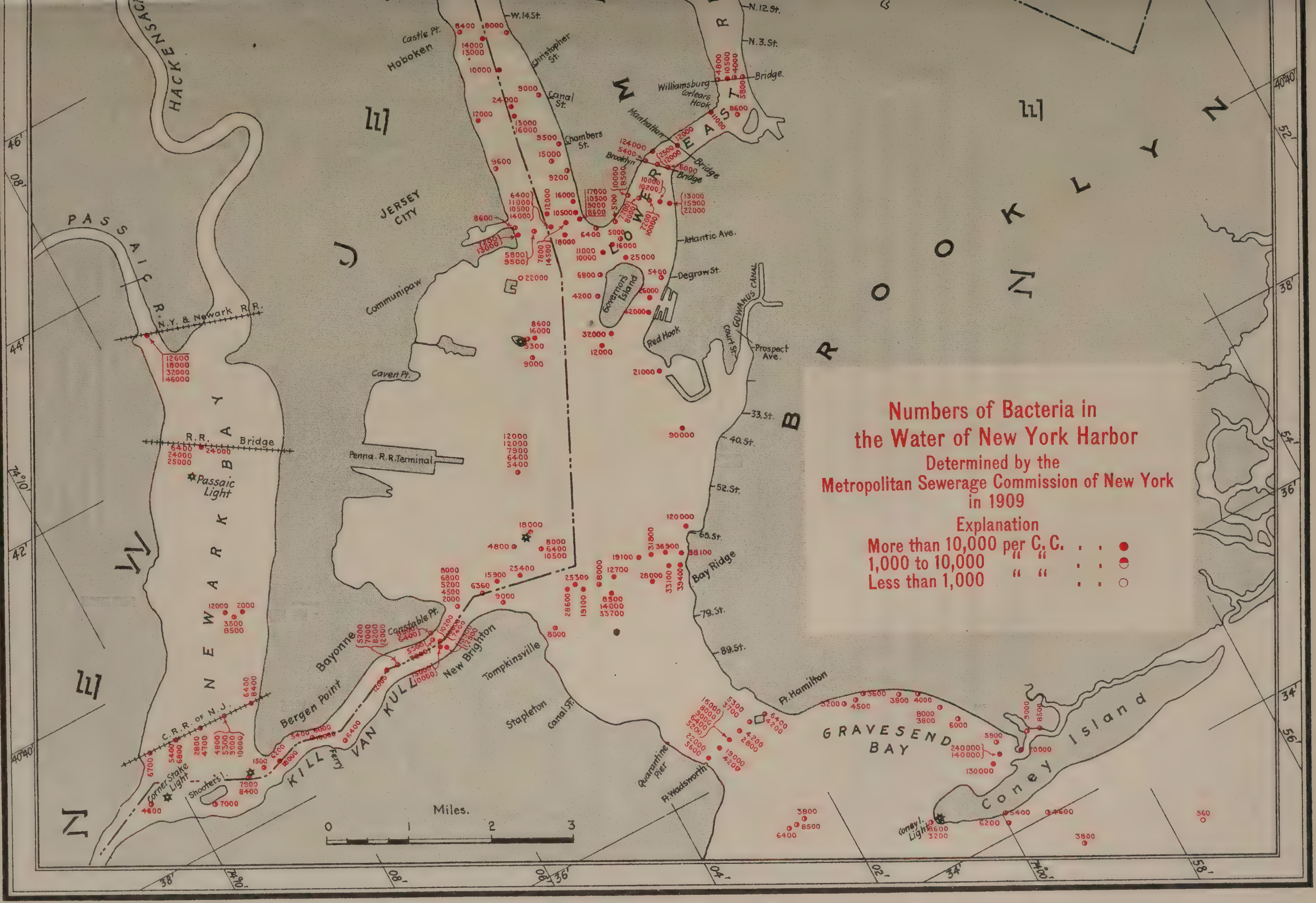
Location	Number of Analyses	Bacteria per C. C.	Samples included in the Averages.
Atlantic ocean, near Lower bay	8	560	424–427, 710–713.
Passaic river, below Newark	16	43,000	323–326, 331–334, 811–814, 935–938.
Rahway river	2	34,000	953–954.
Bodine creek	1	6,400	693.
Total	27		Note.—All samples collected in these regions are included in averages.
Used in Table V	1,100		
Total used in averages	1,127		
Samples not used in averages	35		
Total number of analyses	1,162		

Plate D

Numbers of Bacteria in the Water of New York Harbor in 1909



BRONX
QUEENS
MANHATTAN
UPPER EAST RIVER
FLUSHING BAY
BOWERY BAY
LONG ISLAND CITY
HARLEM RIVER
HUDSON RIVER
State Line
Willets Pt.
Throggs Neck
Whitestone Pt.
Old Ferry Pt.
College Pt.
Clauson's Pt.
Hunts Pt.
BRONX RIVER
Riker's Island
Lawrence Pt.
Randall's Isl.
Ward's Isl.
Blackwells Isl.
Hoyt Ave.
Elm St.
E.138 St.
E.110 St.
E.86 St.
E.72 St.
E.42 St.
Blackwells Bridge
Willis Ave. Bridge
3rd Ave. Bridge
Madison Ave. Bridge
Central Bridge
Washington Bridge
Univ. Hts. Bridge
Kings Bridge
Spuyten Duyvil
R.R. Bridge
Ft. Washington Point
Manhattan Ave.
W.110 St.
W.96 St.
W.79 St.
W.72 St.
W.59 St.
W.42 St.
W.33 St.
Fort Lee
NEWTOWN CREEK
Yonkers
Ludlow
Mt. St. Vincent
Riverdale
46'
48'
50'
52'
54'
56'
73°50'
44'
42'
40°48'



Plotted from Data Contained in Table XV, pp. 226–259.

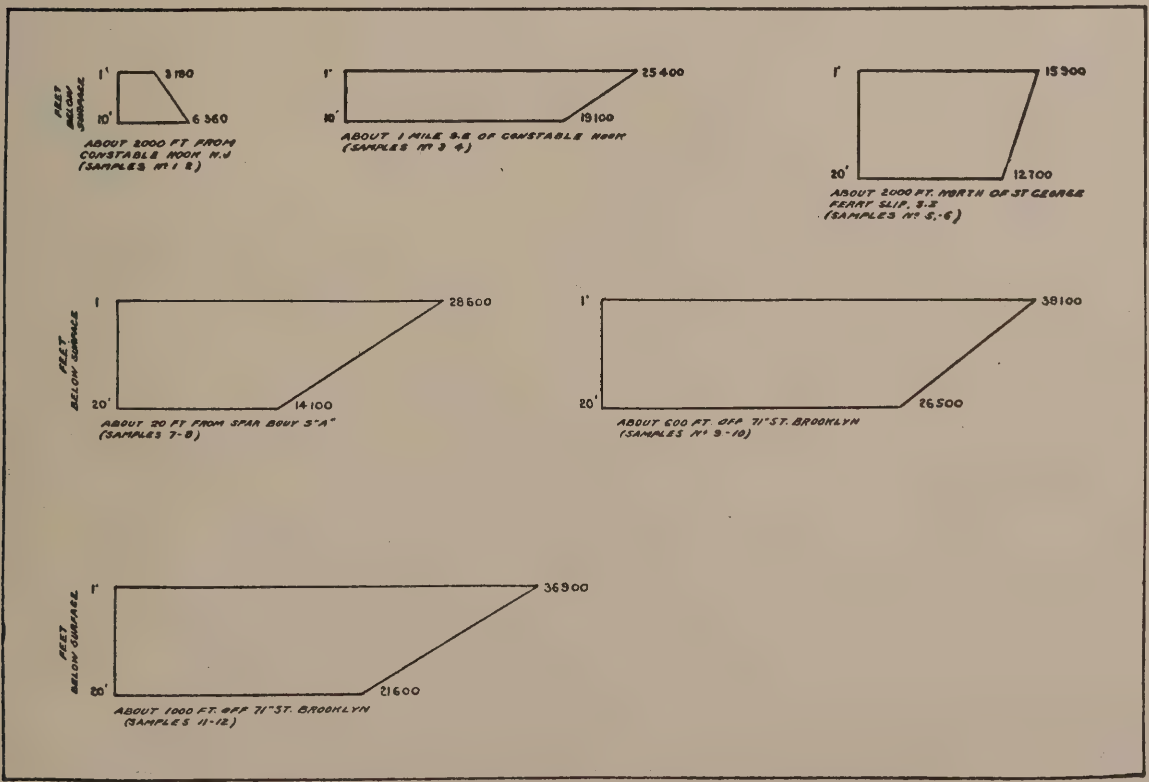
INTRODUCTION TO BACTERIA DIAGRAMS

The following series of diagrams show the numbers of bacteria found in the water at various depths. In each case the depth from which the sample was taken below the surface of the water is indicated by the vertical line and the number of bacteria by a horizontal line opposite the depth at which that number was found. The location and sample numbers are stated in every instance. The data from which these diagrams were made are contained in Table XV, pp. 226-259.

BACTERIA DIAGRAMS

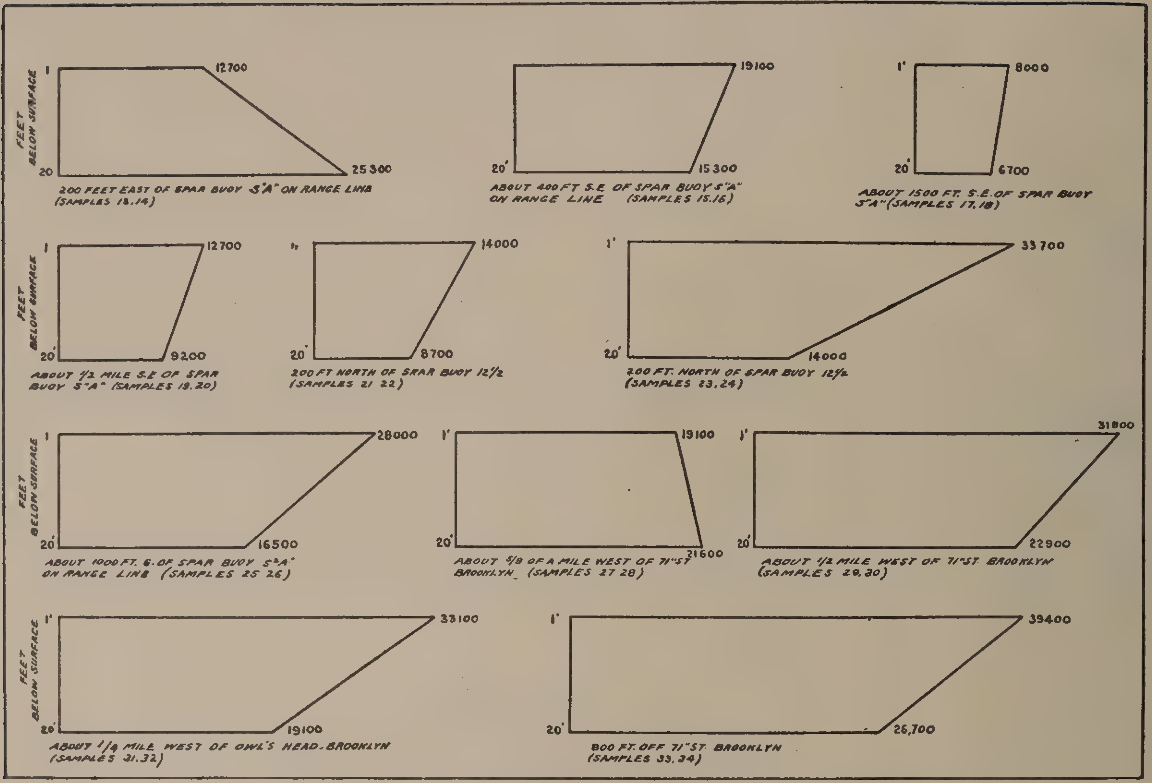
Diagrams showing numbers of bacteria in the water at different depths in various parts of the harbor in the year 1909.

FIG. 22



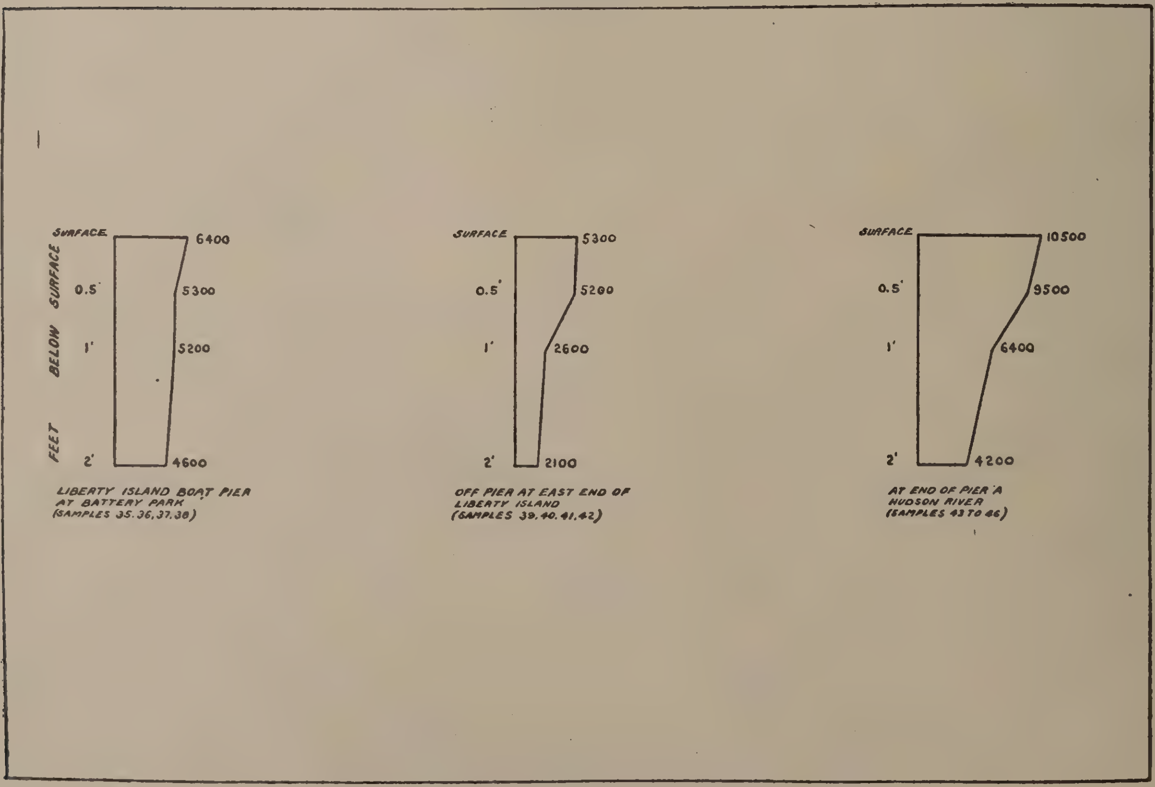
ACROSS UPPER BAY FROM CONSTABLE HOOK N.J TO 71ST ST. BROOKLYN
BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED MARCH 23RD 1909

FIG. 23



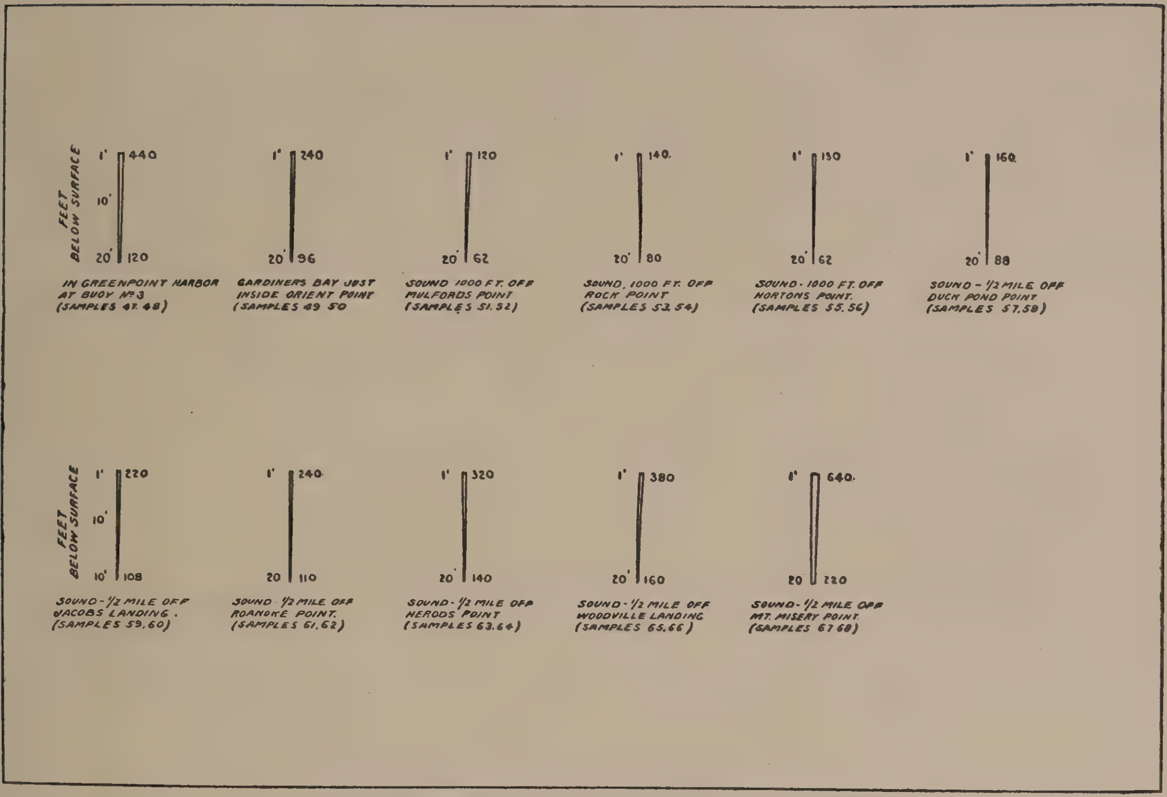
ACROSS UPPER BAY FROM CONSTABLE HOOK N.J. TO 71ST ST. BROOKLYN (CONT'D)
BACTERIA PER C.C IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED MARCH 24TH 1909

FIG. 24



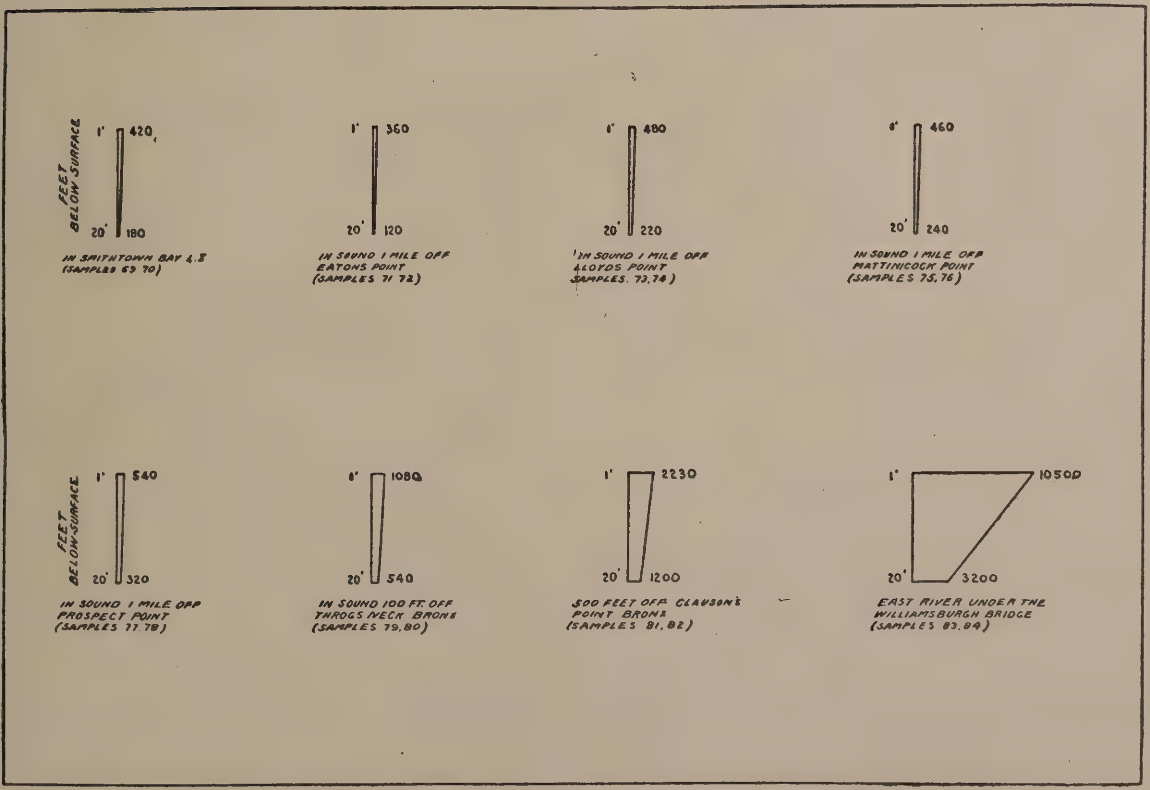
UPPER N.Y. BAY AT BATTERY PARK PIER, LIBERTY I. & PIER 'A'
BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED APRIL 7TH 1909

FIG. 25



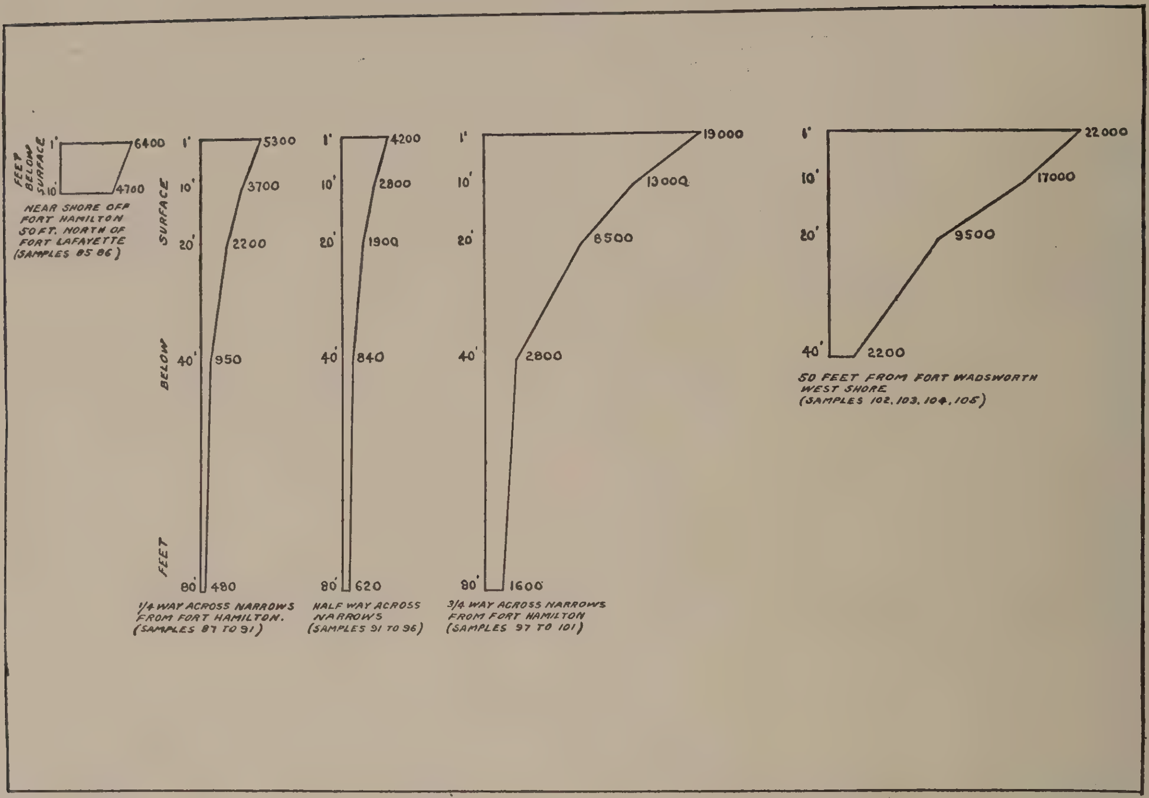
LONG ISLAND SOUND FROM GREENPORT L. I. TO NEW YORK CITY
BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED APRIL 13TH 1909

FIG. 26



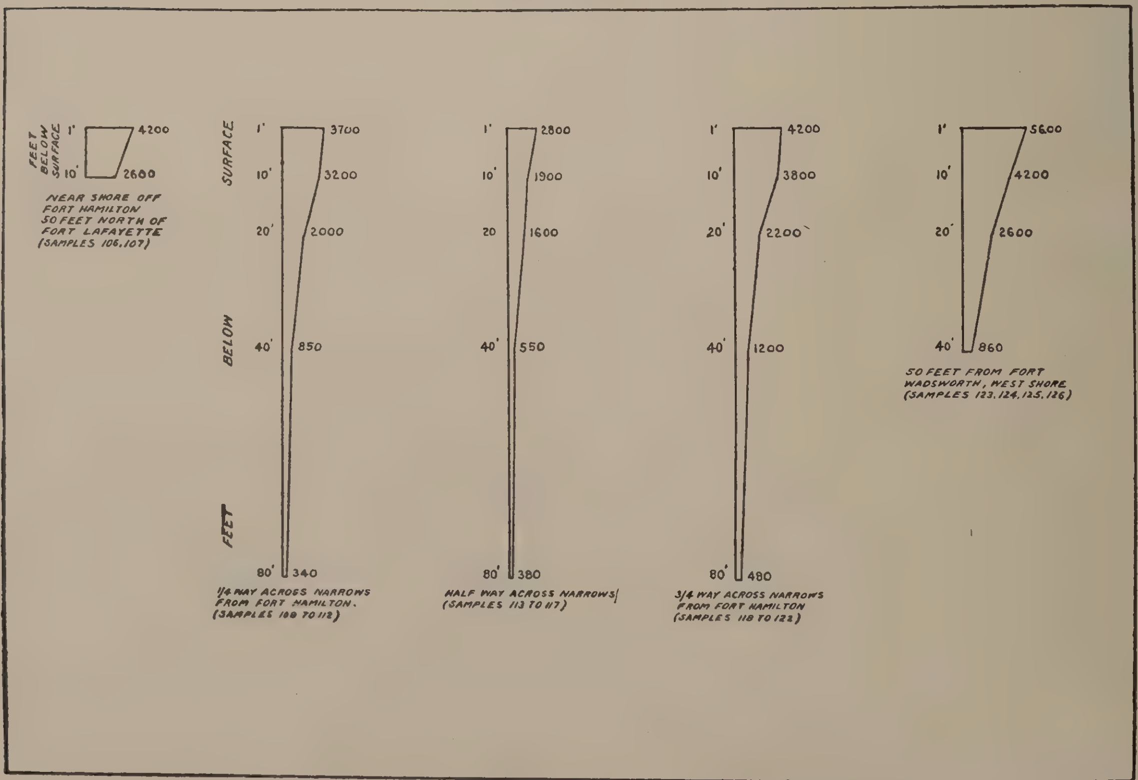
LONG ISLAND SOUND FROM GREENPORT L. I. TO NEW YORK CITY
BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED APRIL 15TH 1909

FIG. 27



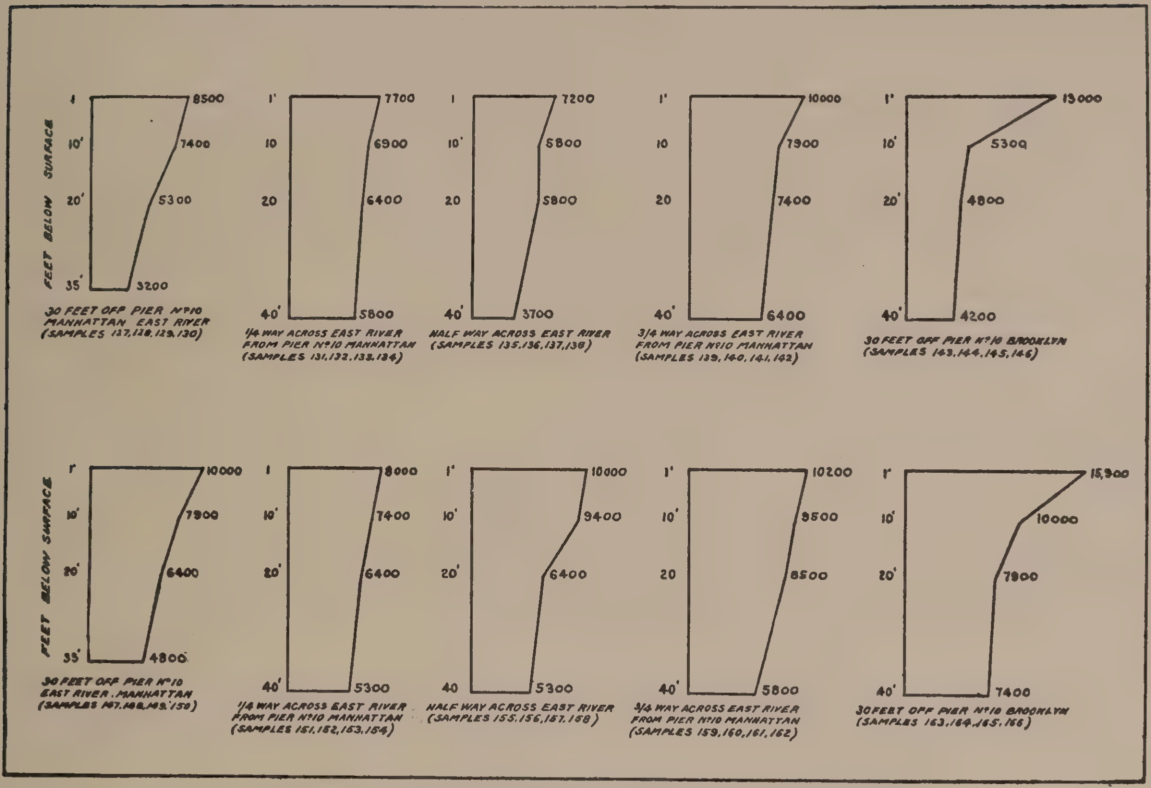
ACROSS NARROWS FROM FORT HAMILTON TO FORT WADSWORTH
BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED APRIL 19TH 1909

FIG. 28



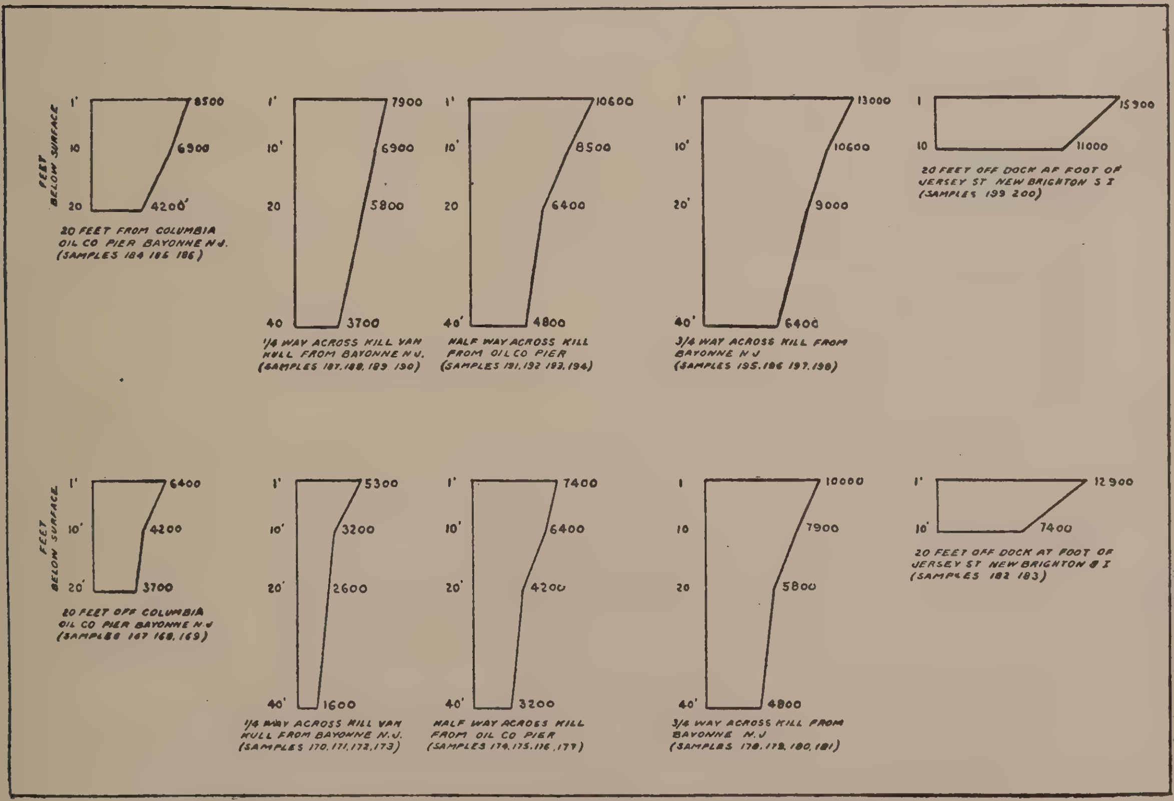
ACROSS NARROWS FROM FORT HAMILTON TO FORT WADSWORTH
BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED APRIL 19TH 1909

FIG. 29



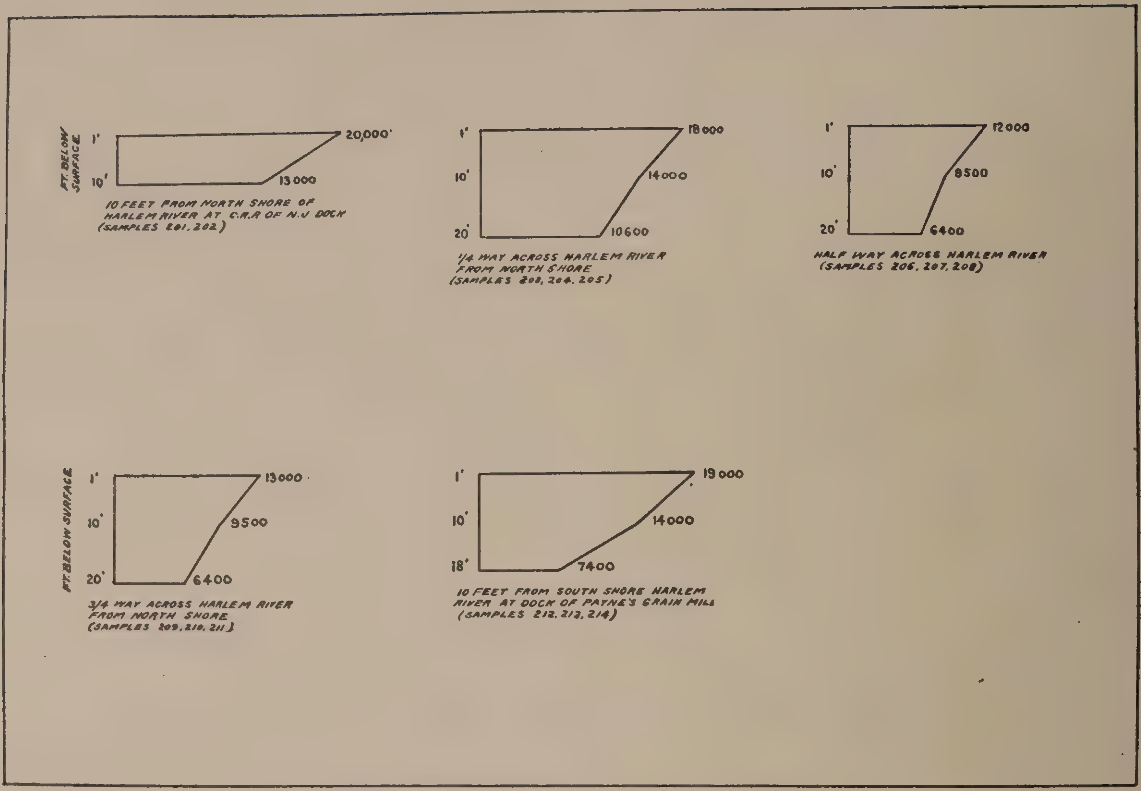
ACROSS EAST RIVER FROM PIER Nº10 MANHATTAN TO PIER Nº10 BROOKLYN
BACTERIA PER C.C IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED APRIL 22ND 1909

FIG. 30



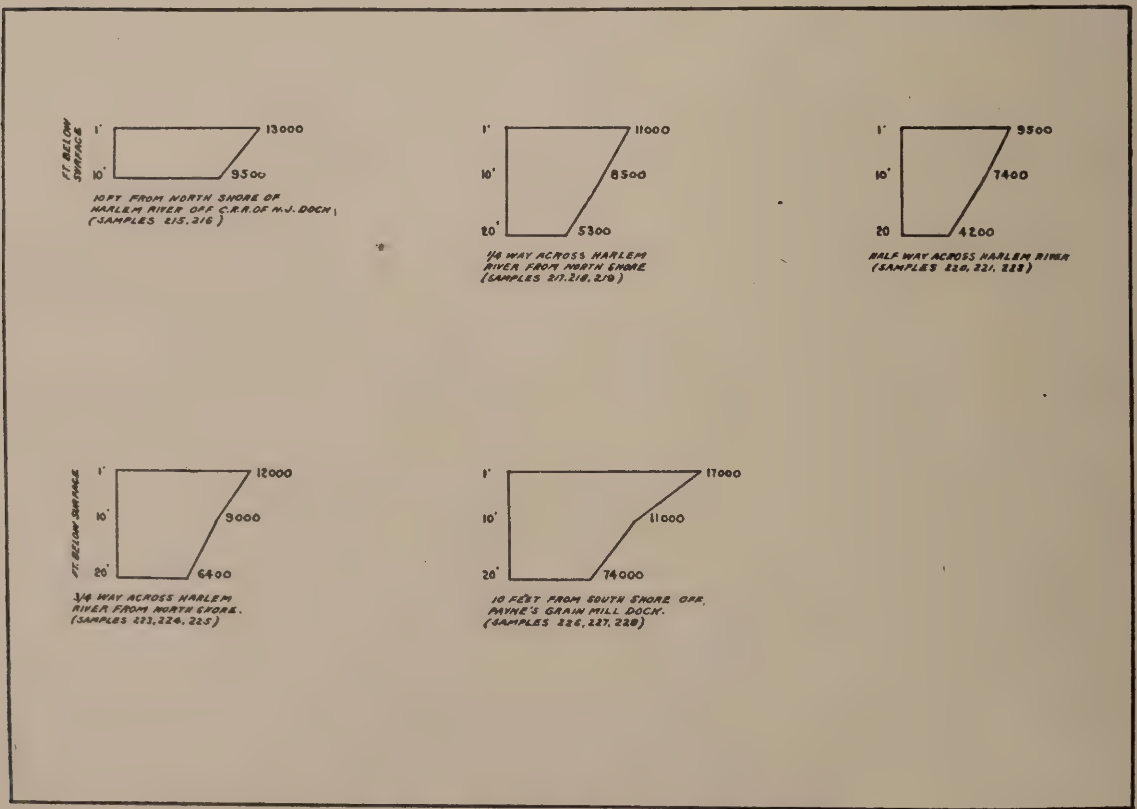
ACROSS KILL VAN KULL FROM BAYONNE N.J TO NEW BRIGHTON S.I.
BACTERIA PER C C IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED APRIL 26TH 1909

FIG. 31



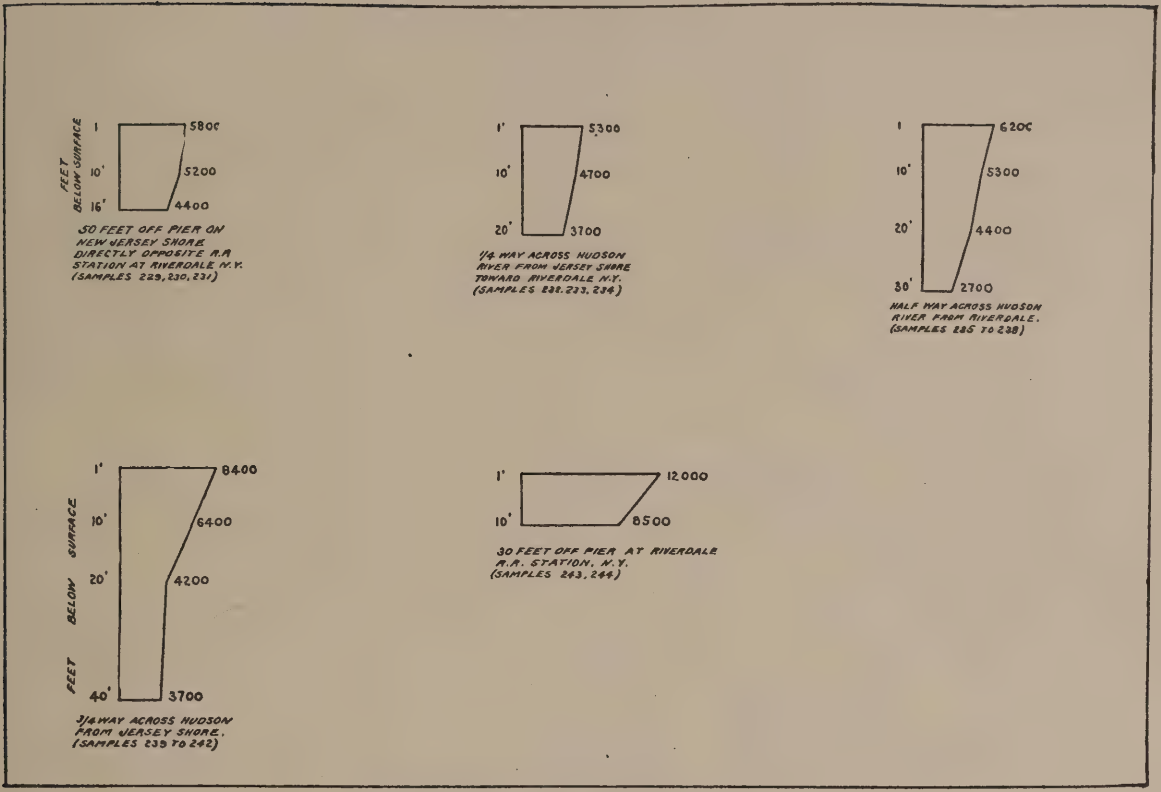
ACROSS HARLEM RIVER JUST EAST OF 3RD AVE. BRIDGE
BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE.
SAMPLES COLLECTED APRIL 27TH 1909

FIG. 32



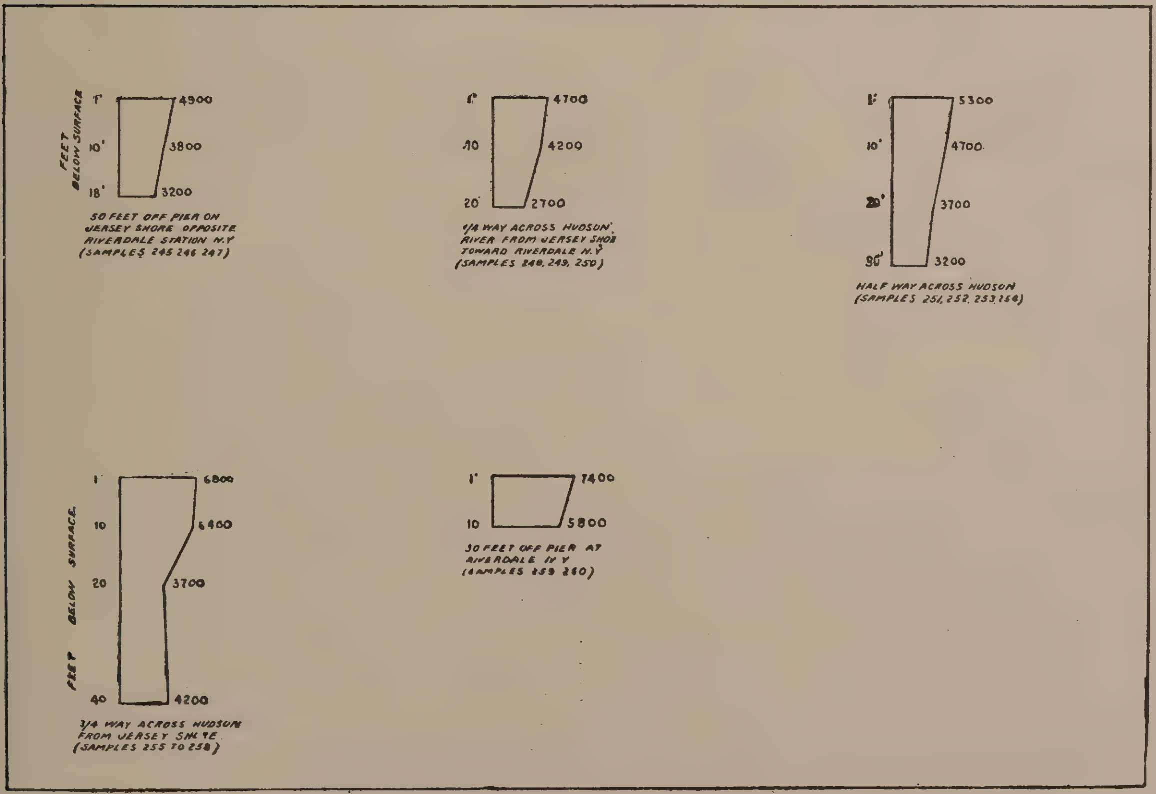
ACROSS HARLEM RIVER JUST EAST OF 3RD AVE. BRIDGE
BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED APRIL 27TH 1909

FIG. 33



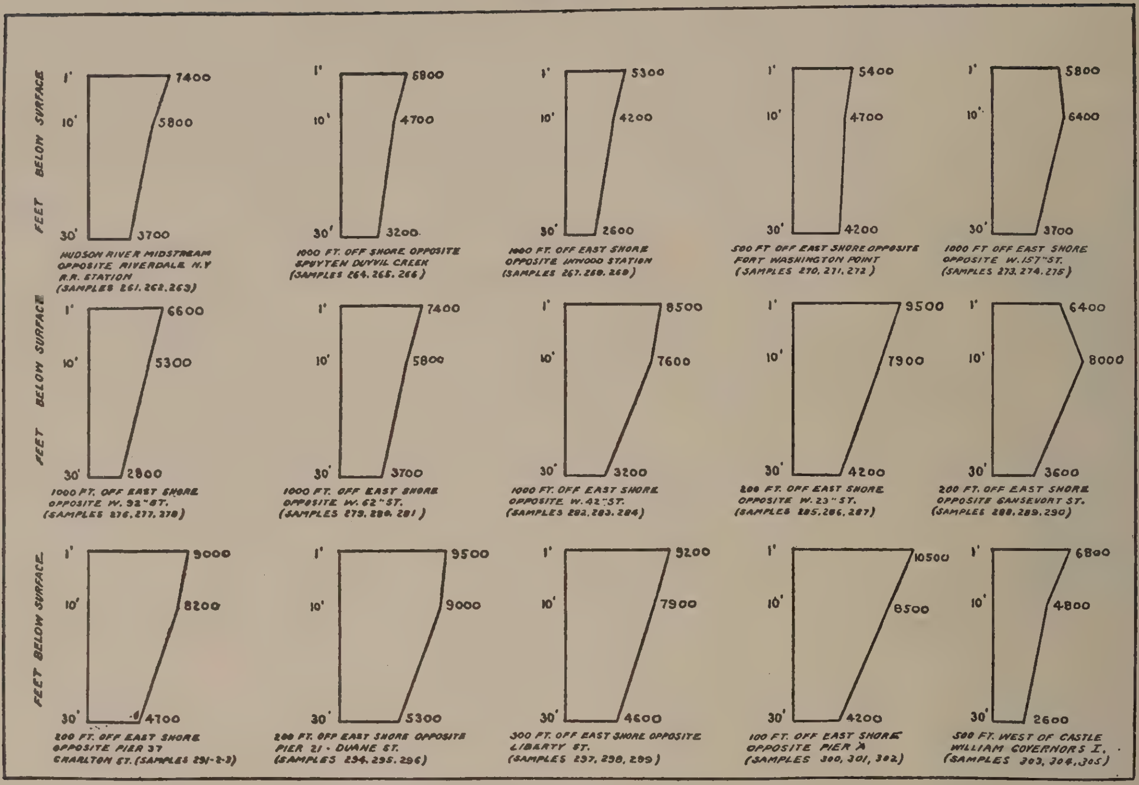
ACROSS HUDSON RIVER FROM RIVERDALE NEW YORK
BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED MAY 3RD 1909

FIG. 34



ACROSS HUDSON RIVER FROM RIVERDALE N.Y.
BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED MAY 3RD 1909

FIG. 35

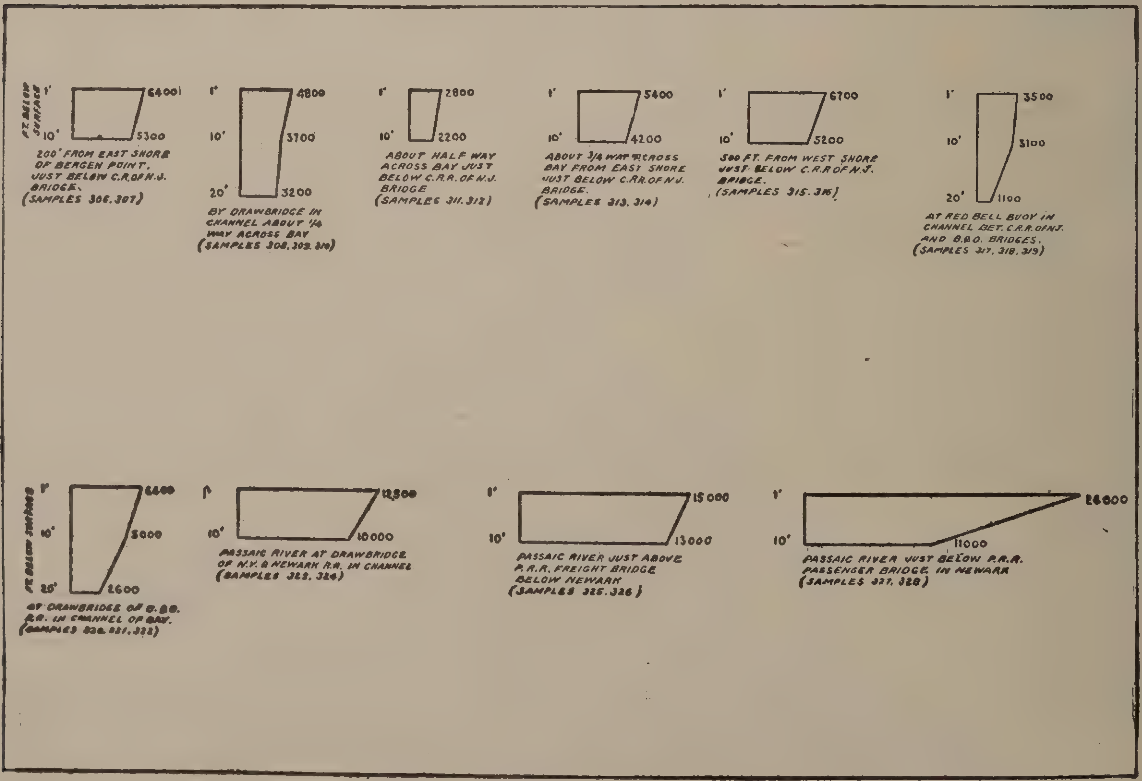


HUDSON RIVER FROM RIVERDALE TO BATTERY

BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE

SAMPLES COLLECTED MAY 4TH 1909

FIG. 36

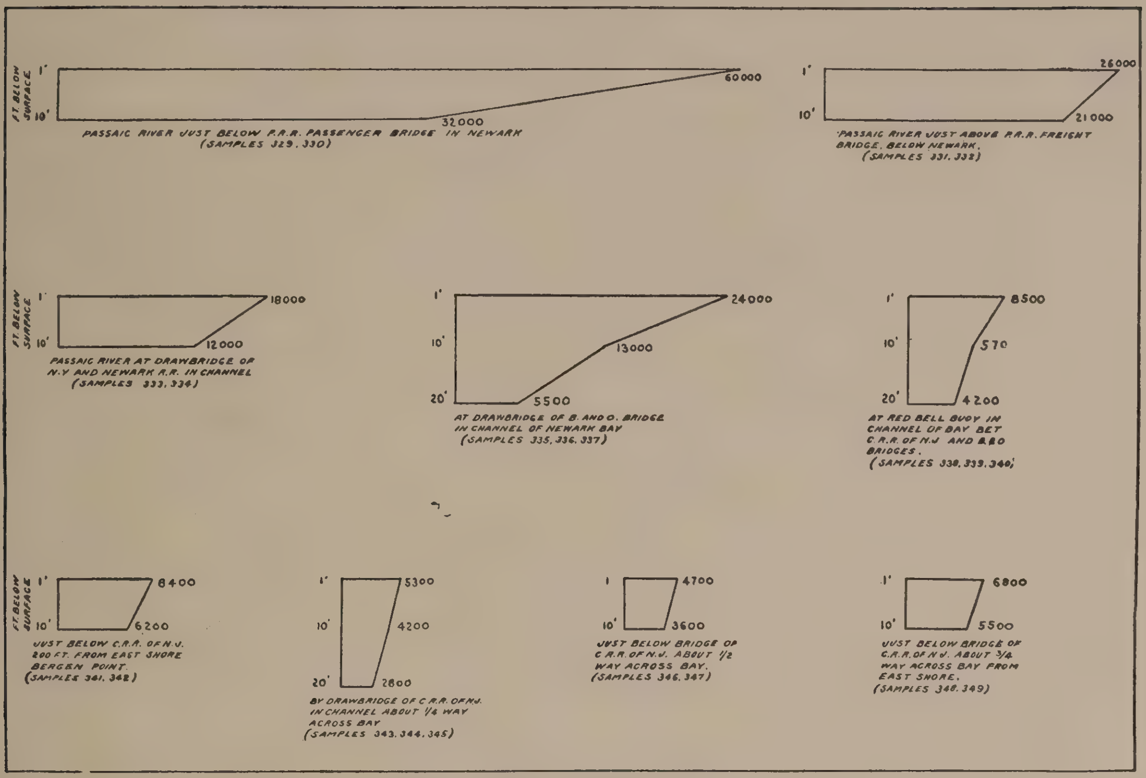


NEWARK BAY AND PASSAIC RIVER

BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE

SAMPLES COLLECTED MAY 10TH 1909

FIG 37

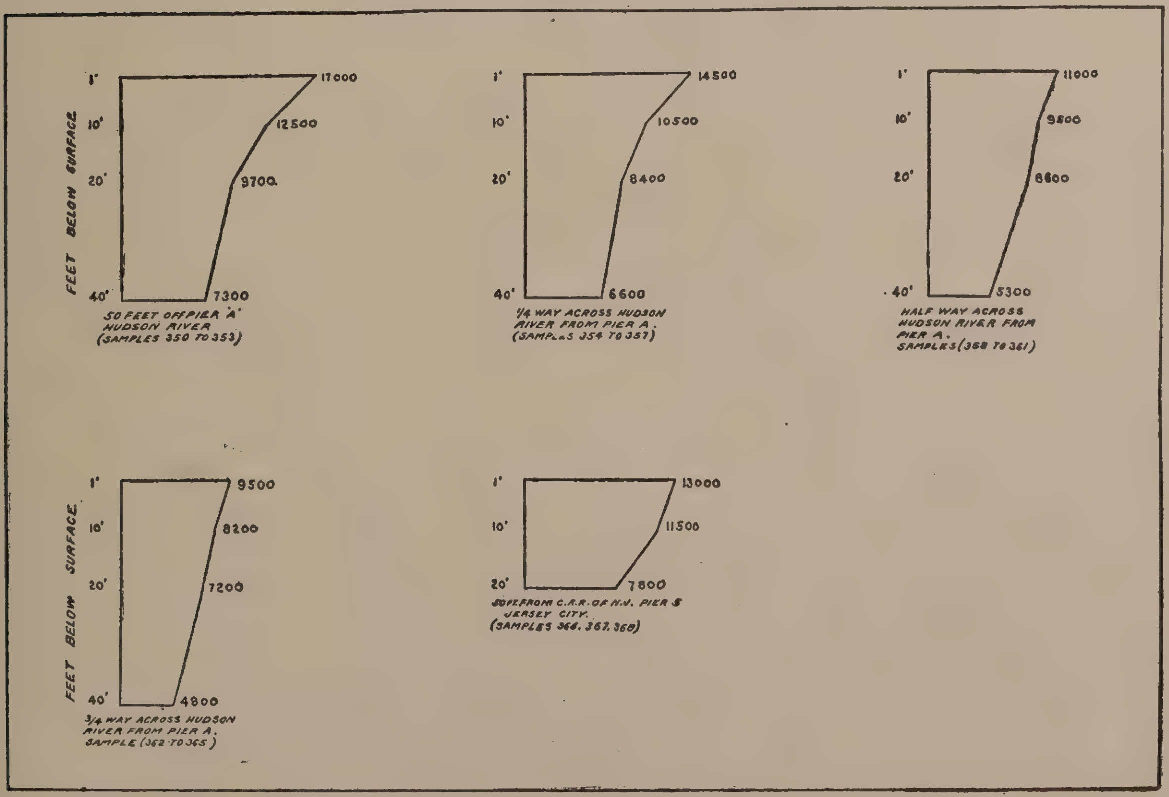


PASSAIC RIVER AND NEWARK BAY

BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE

SAMPLES COLLECTED MAY 10 - 1909

FIG. 38

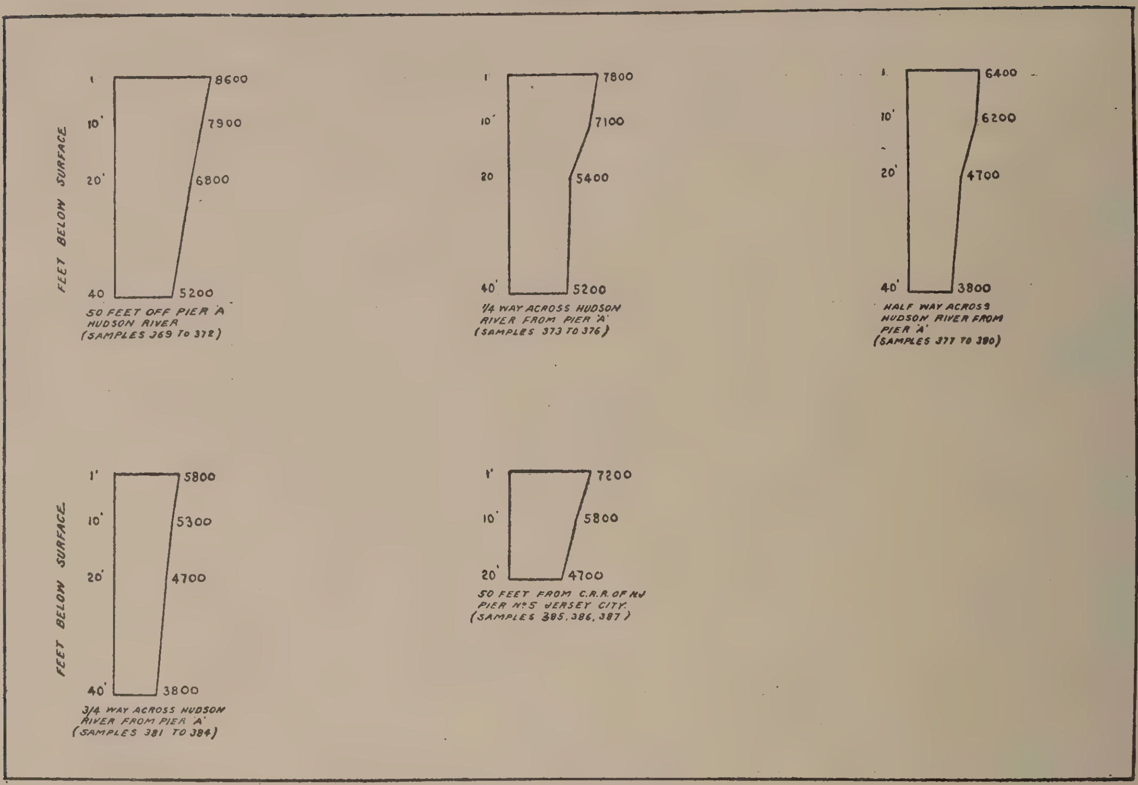


ACROSS HUDSON RIVER FROM PIER 'A'

BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE

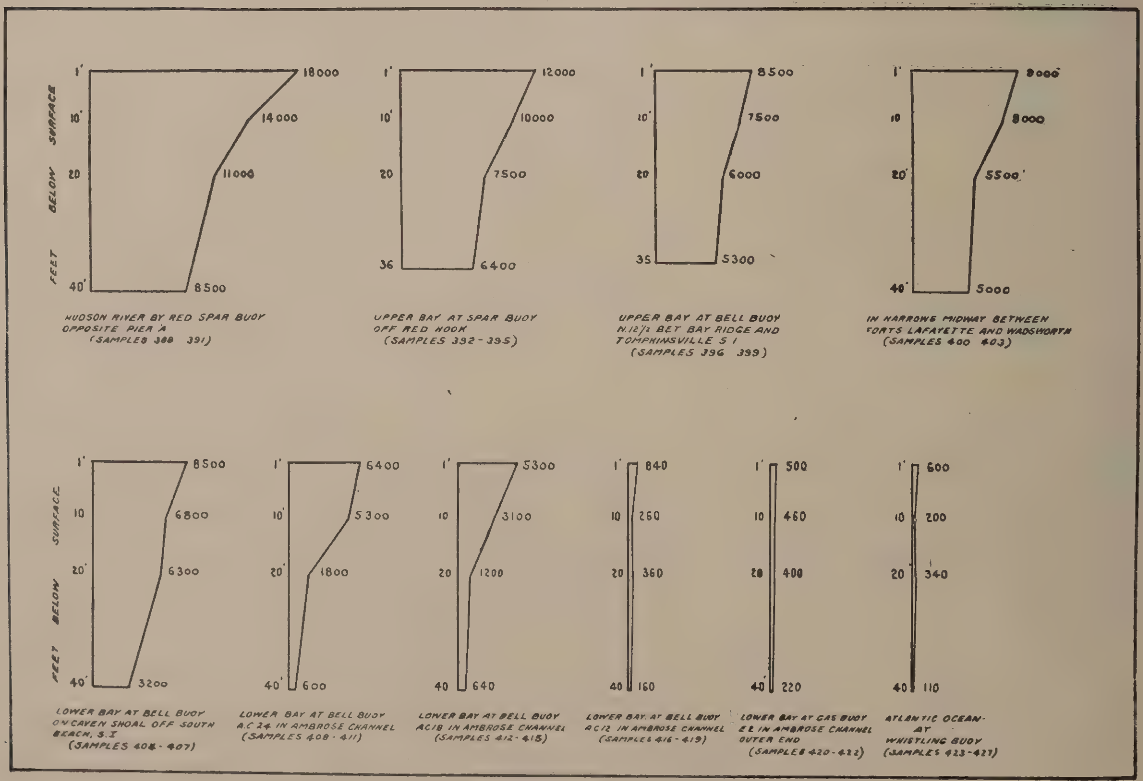
SAMPLES COLLECTED MAY 11 - 1909

FIG. 39



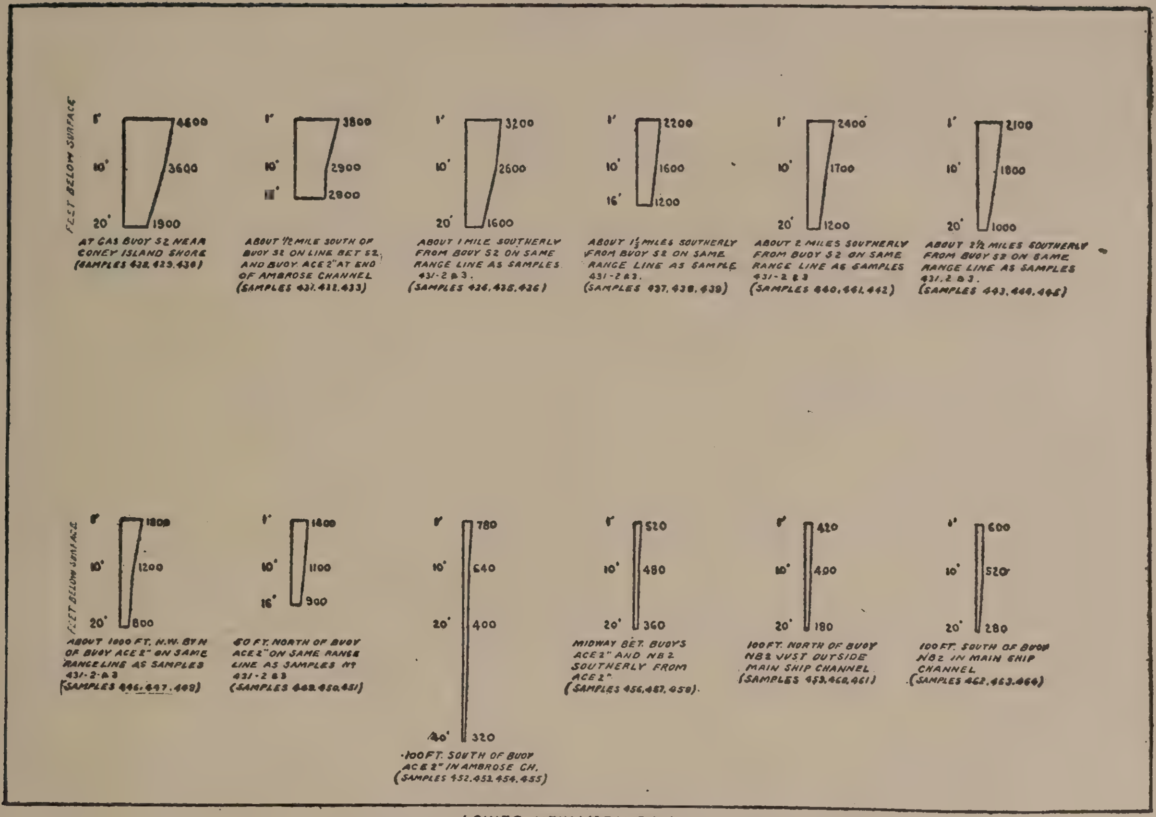
ACROSS HUDSON RIVER FROM PIER 'A'
BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED MAY 12TH 1909

FIG. 40



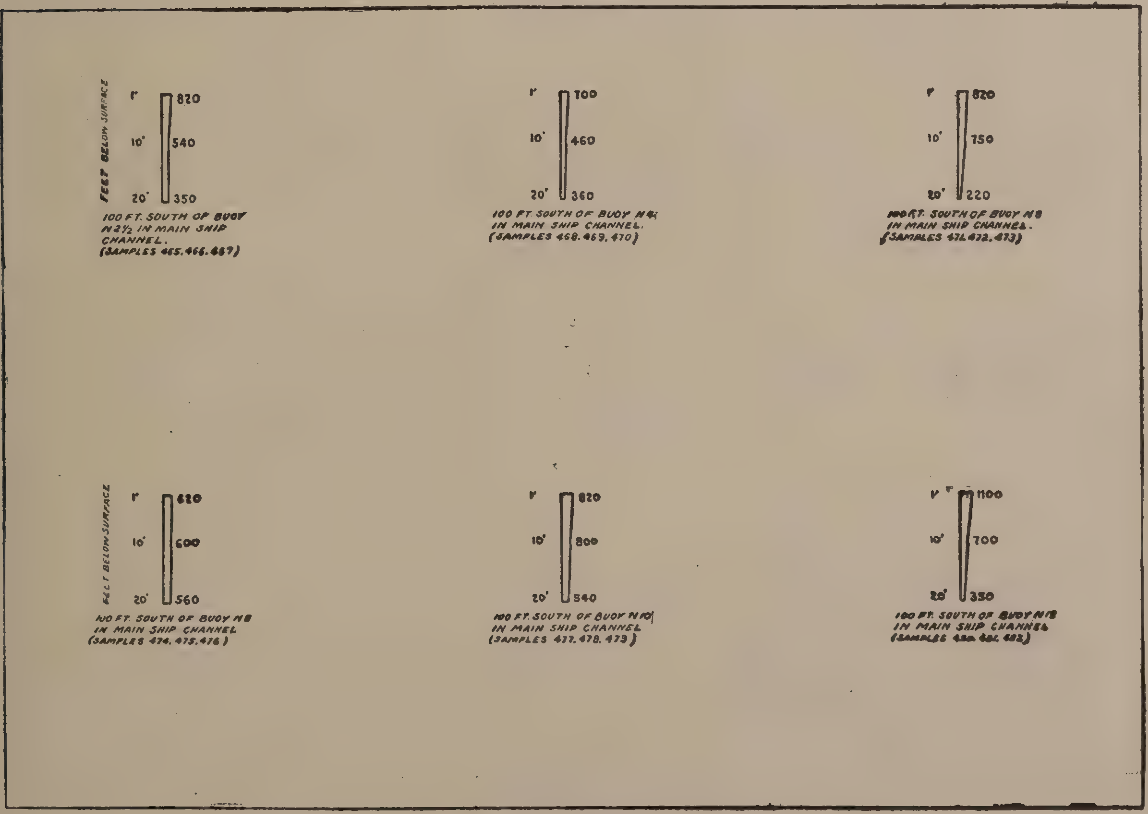
FROM PIER A, THROUGH UPPER BAY THE NARROWS AND LOWER BAY
BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED MAY 13TH 1909

FIG. 41



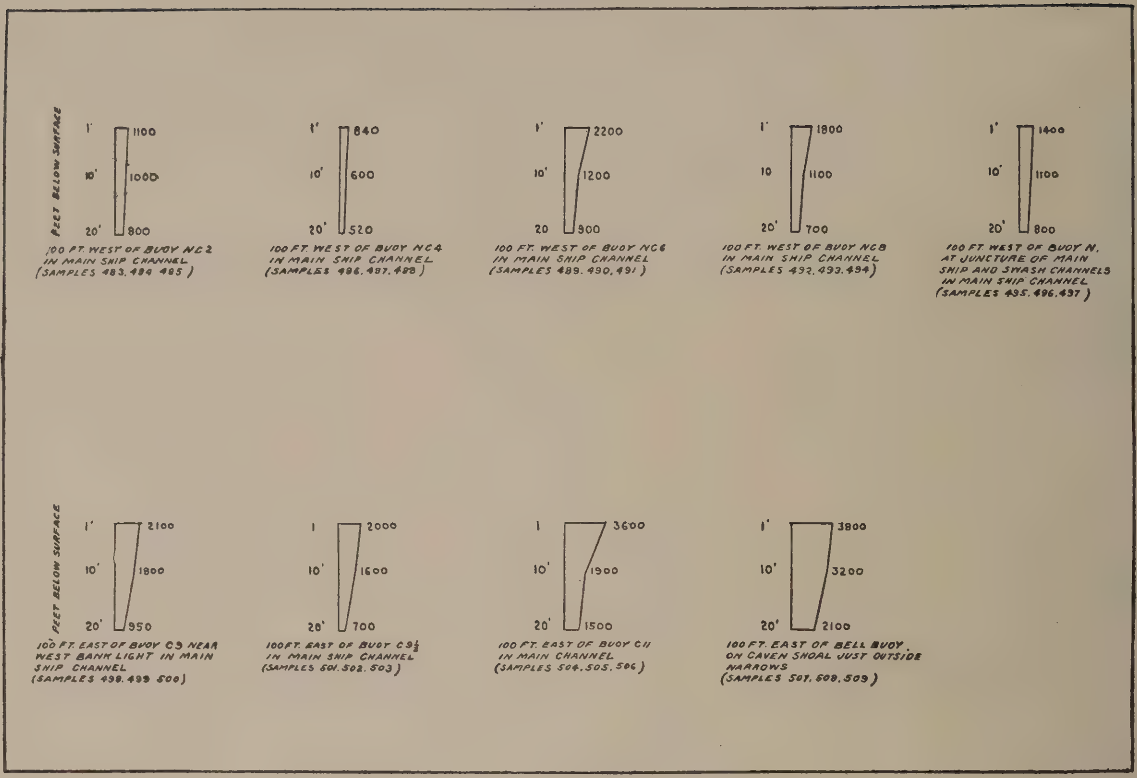
LOWER NEW YORK BAY
BACTERIA PER C.C. IN WATER AT DIFFERENT. DEPTHS BELOW SURFACE
SAMPLES COLLECTED ON MAY 17 AND 18, 1909

FIG. 42



LOWER BAY
BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED MAY 18- 1909

FIG. 43

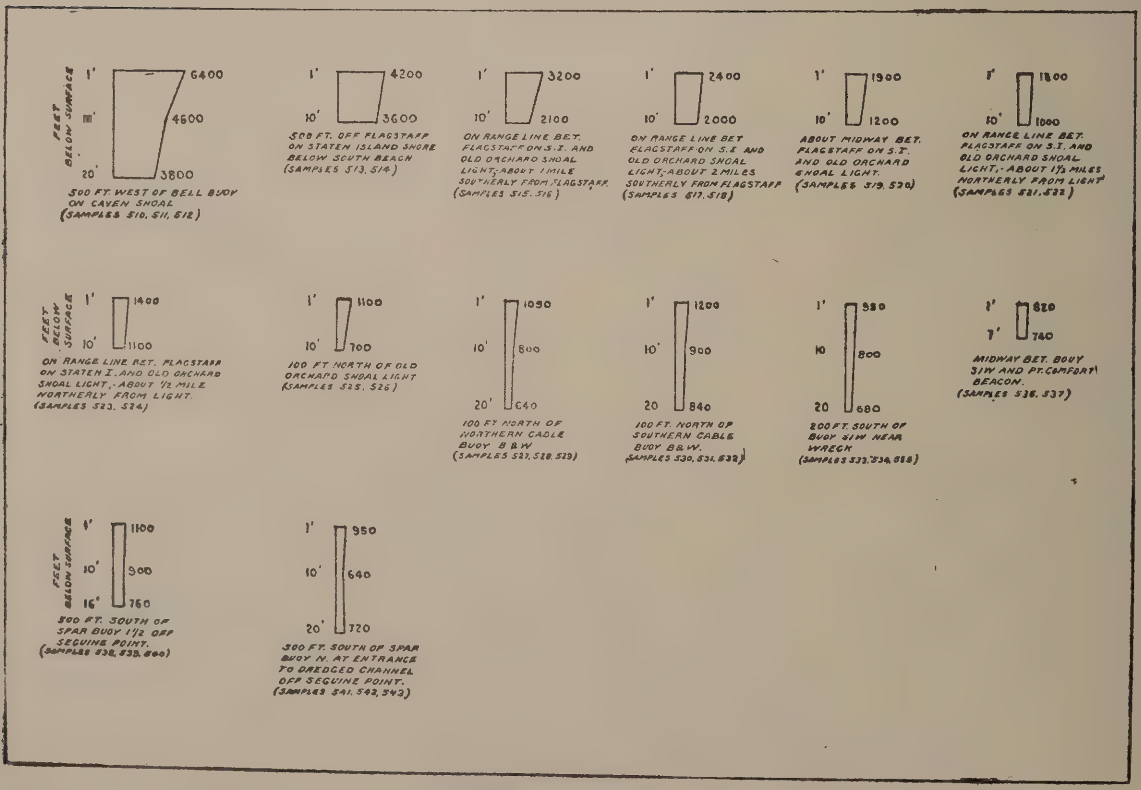


LOWER NEW YORK BAY

BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE

SAMPLES COLLECTED MAY 18-1909

FIG. 44

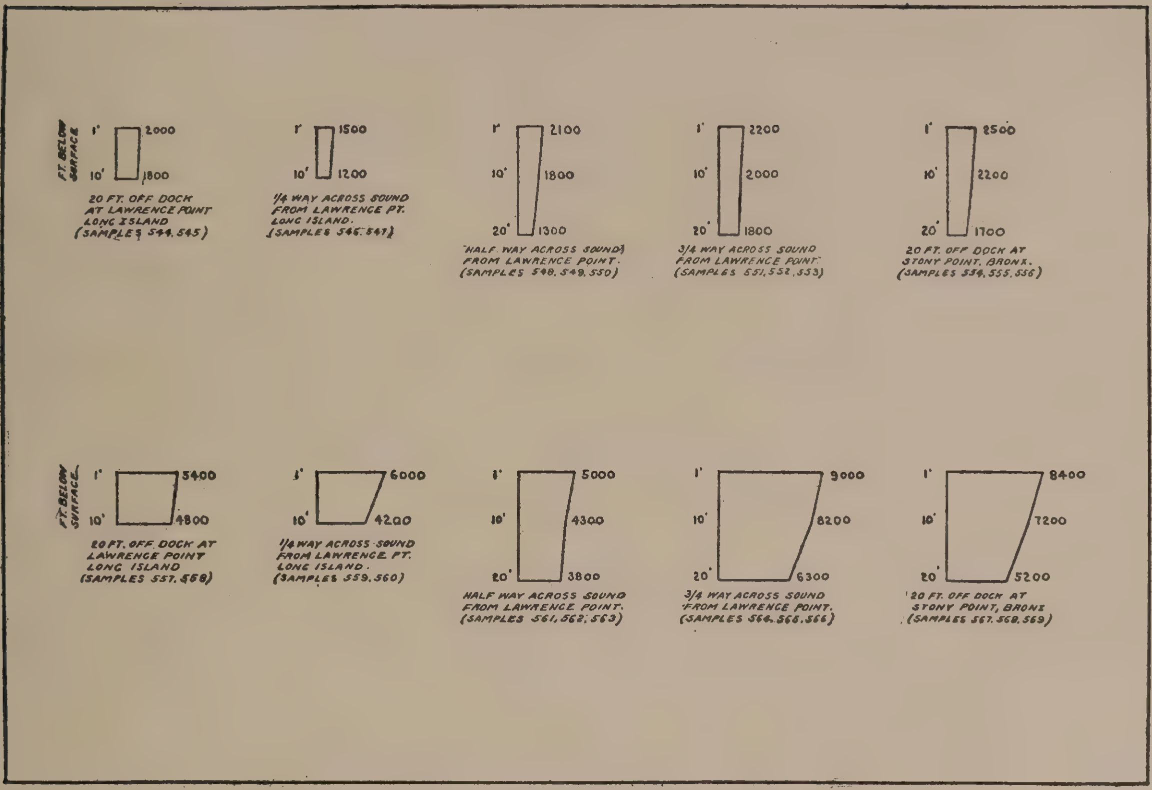


LOWER NEW YORK BAY

BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE

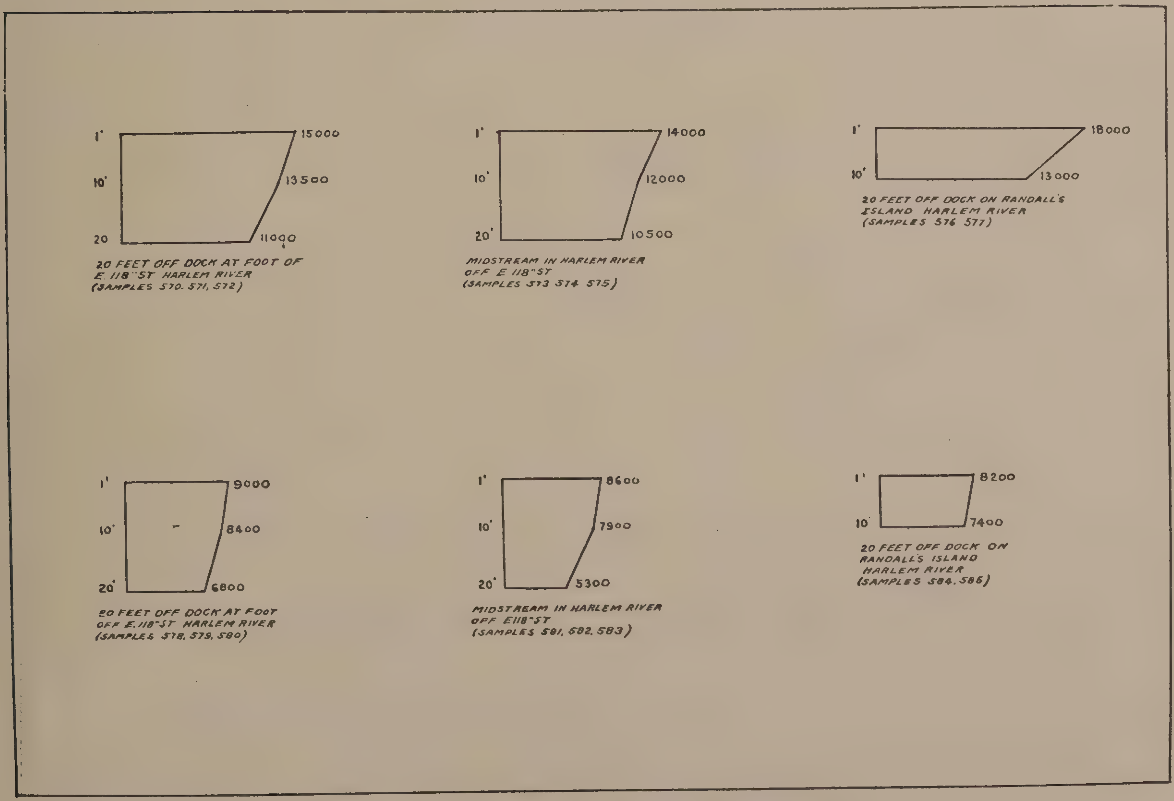
SAMPLES COLLECTED MAY 19-1909

FIG. 45



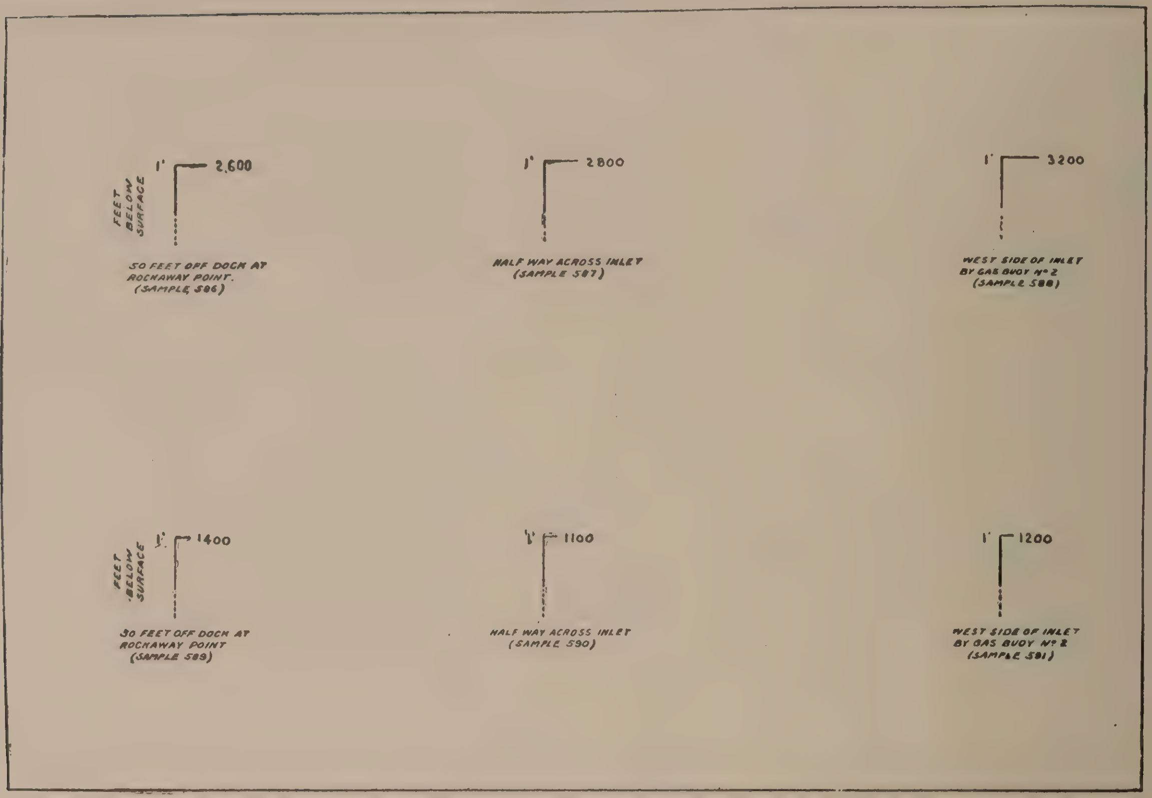
LONG ISLAND SOUND FROM LAWRENCE PT. L. I. TO STONY PT. BRONX
BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED MAY 26TH 1909

FIG. 46



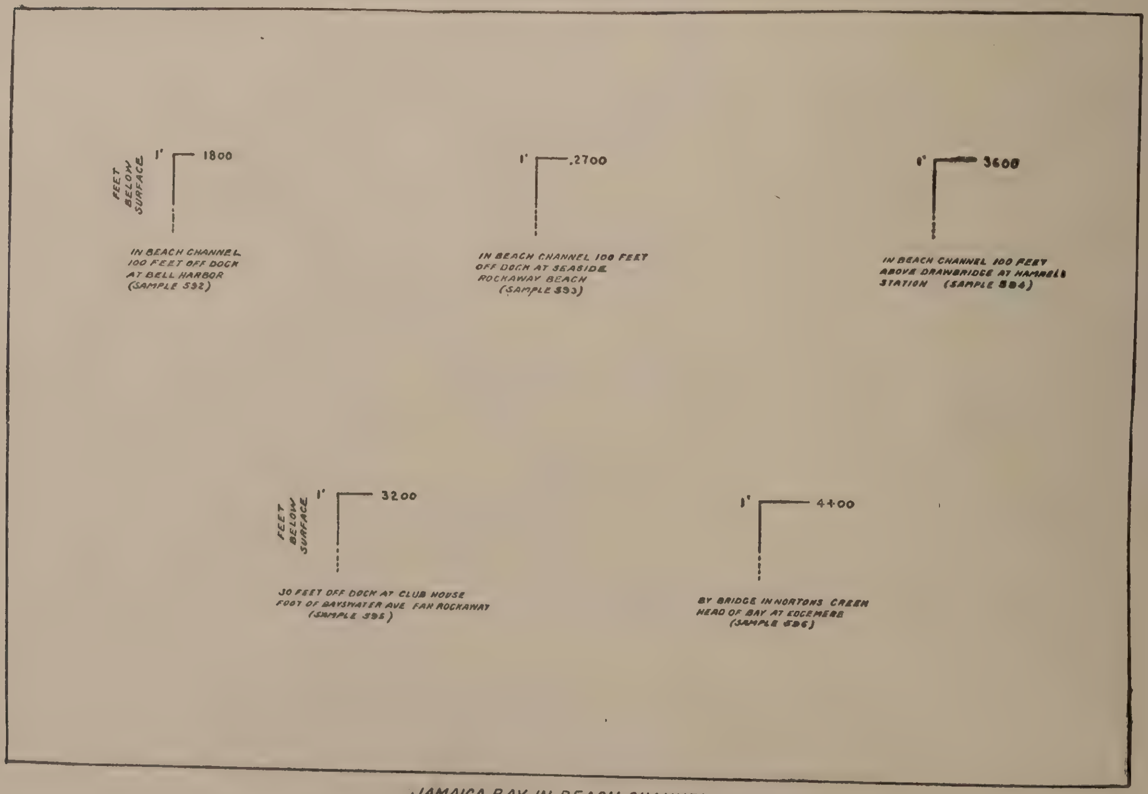
HARLEM RIVER FROM FOOT OF E. 118TH ST. TO RANDALL'S I.
BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED MAY 26TH 1909

FIG. 47



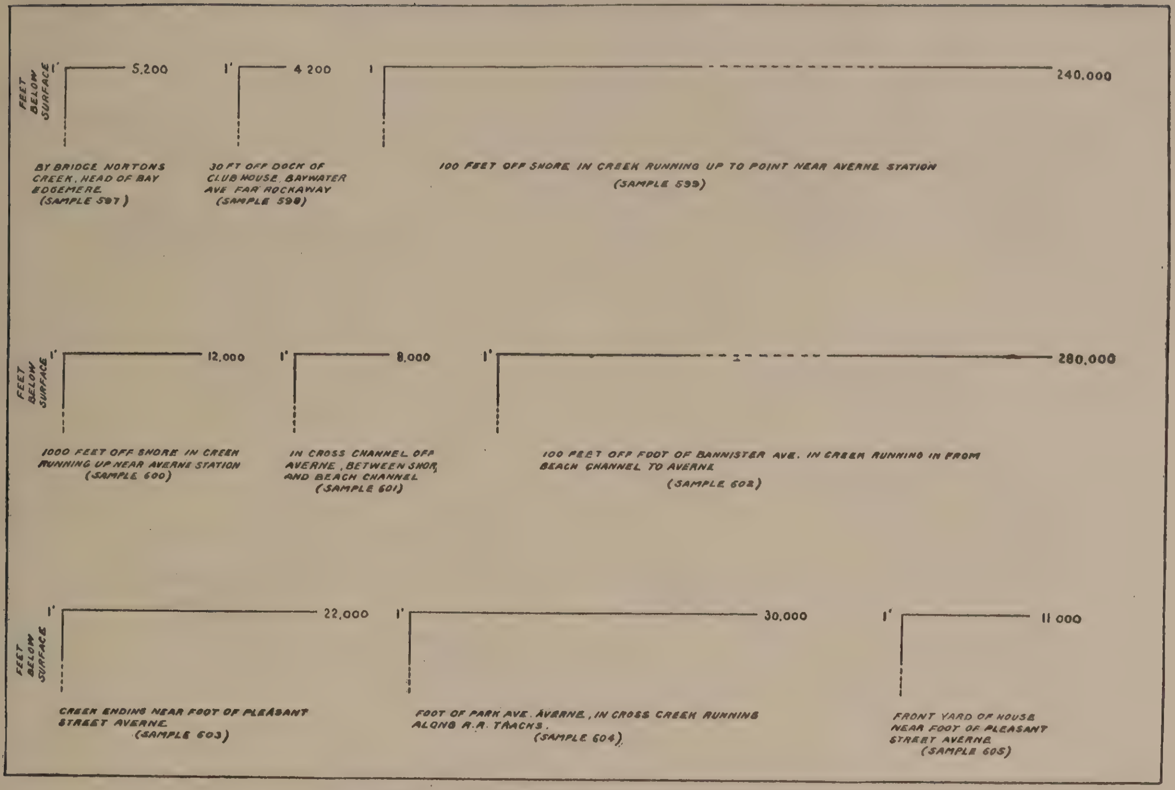
ACROSS ROCKAWAY INLET
BACTERIA PER C.C IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED JUNE 29TH & JULY 1ST '09

FIG. 48



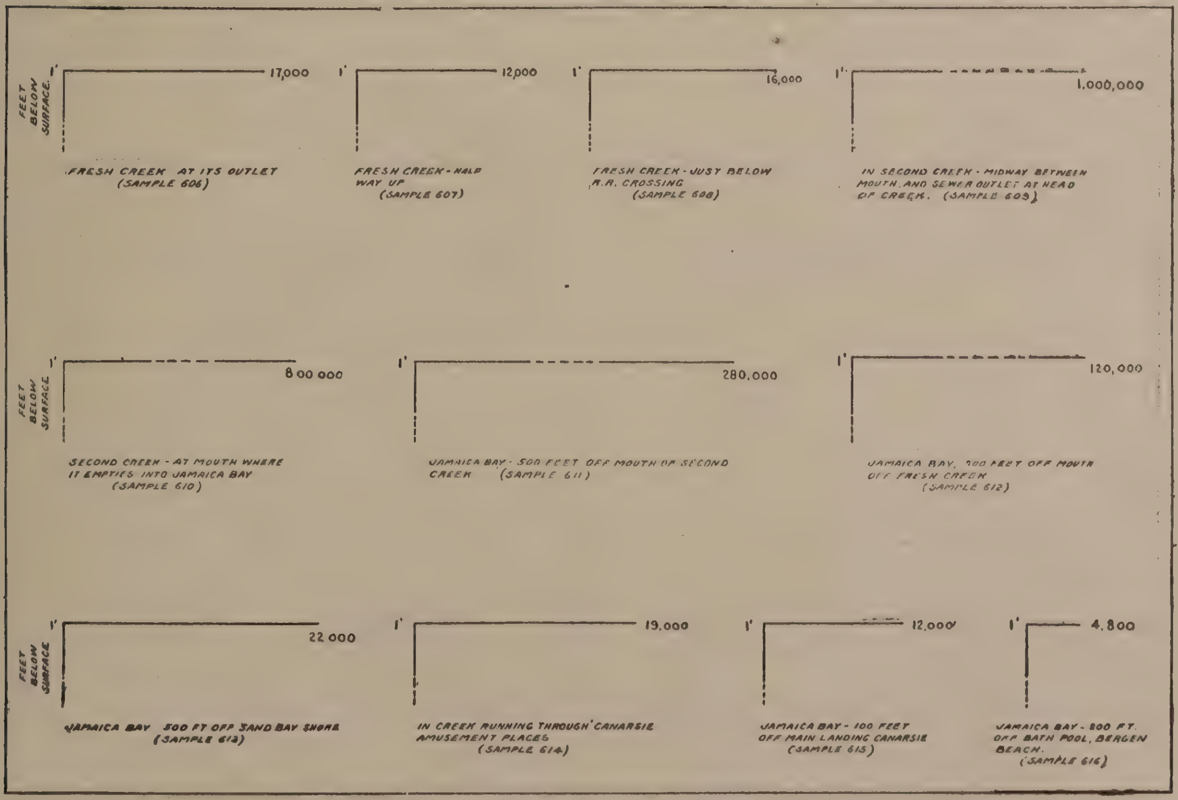
JAMAICA BAY IN BEACH CHANNEL
BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED JUNE 29TH '09

FIG. 49



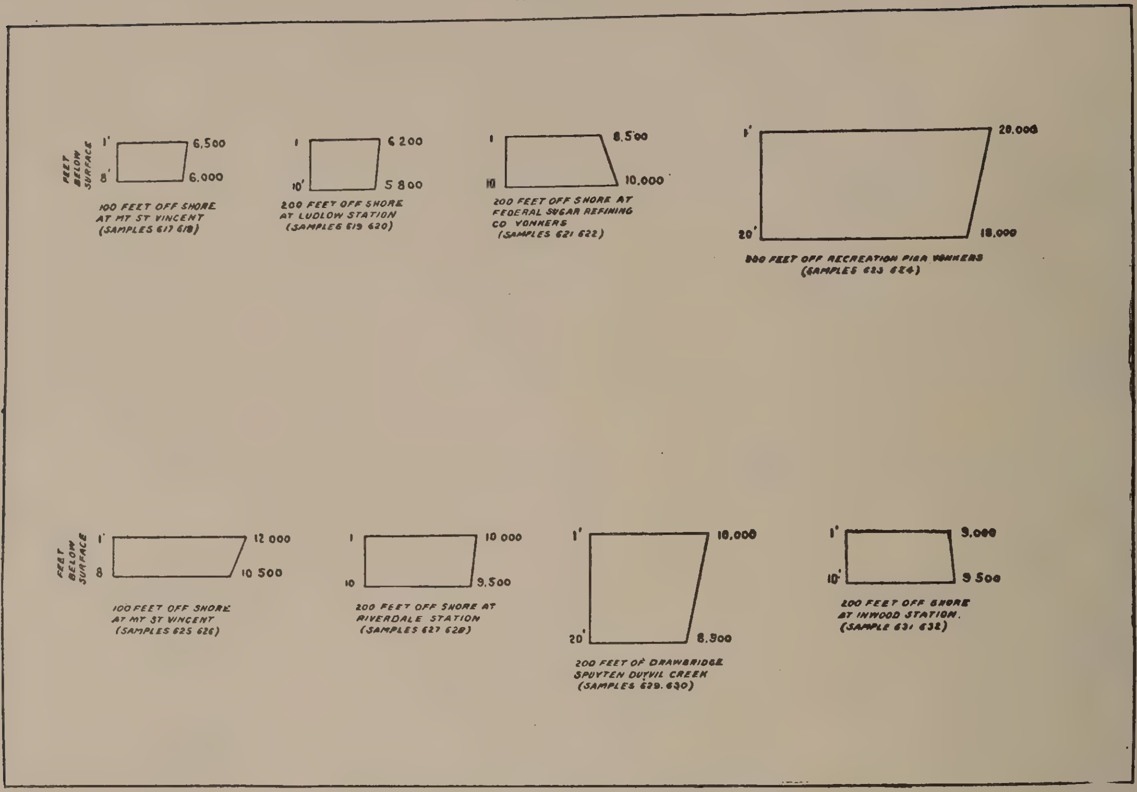
JAMAICA BAY – AVERNE AND ROCKAWAY SHORES
BACTERIA PER C C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED JUNE 30TH 1909

FIG. 50



JAMAICA BAY — BROOKLYN SHORE
BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED JULY 1ST '09

FIG. 51

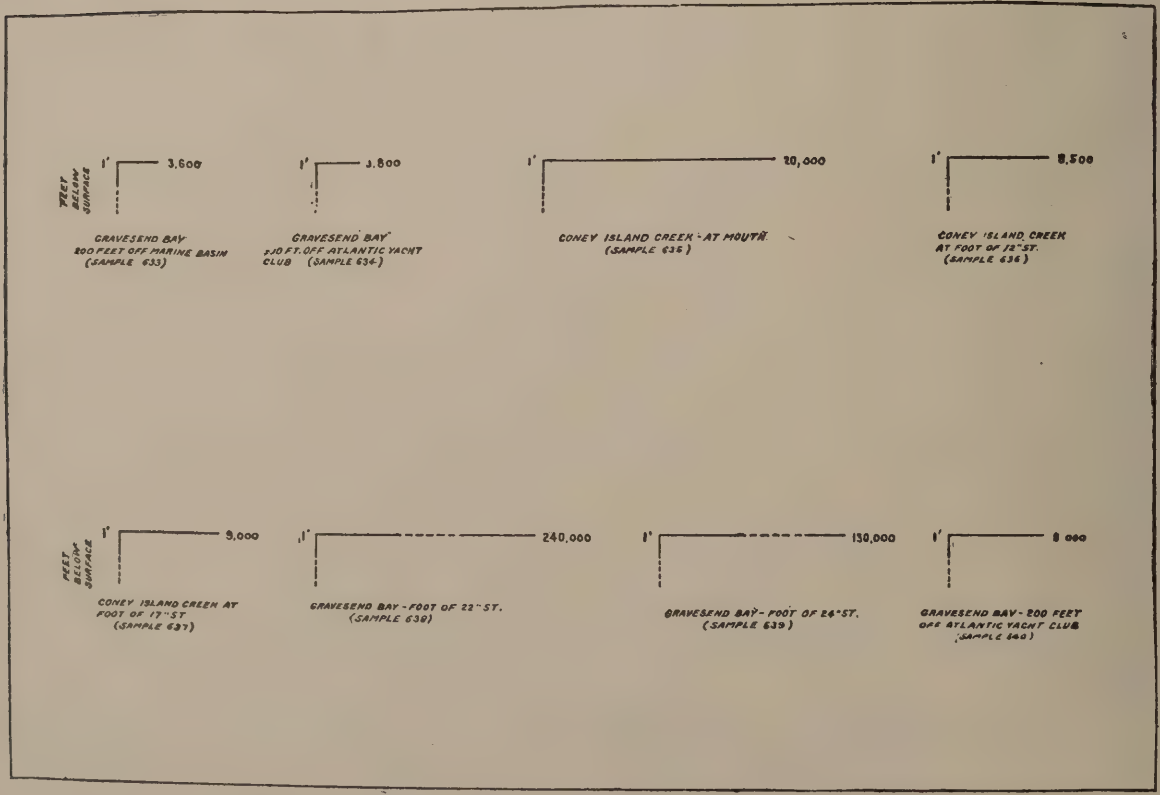


HUDSON RIVER – SPUYTEN DUYVIL TO YONKERS

BACTERIA PER C C IN WATER AT DIFFERENT DEPTHS BELOW SURFACE

SAMPLES COLLECTED JULY 7TH '09

FIG. 52

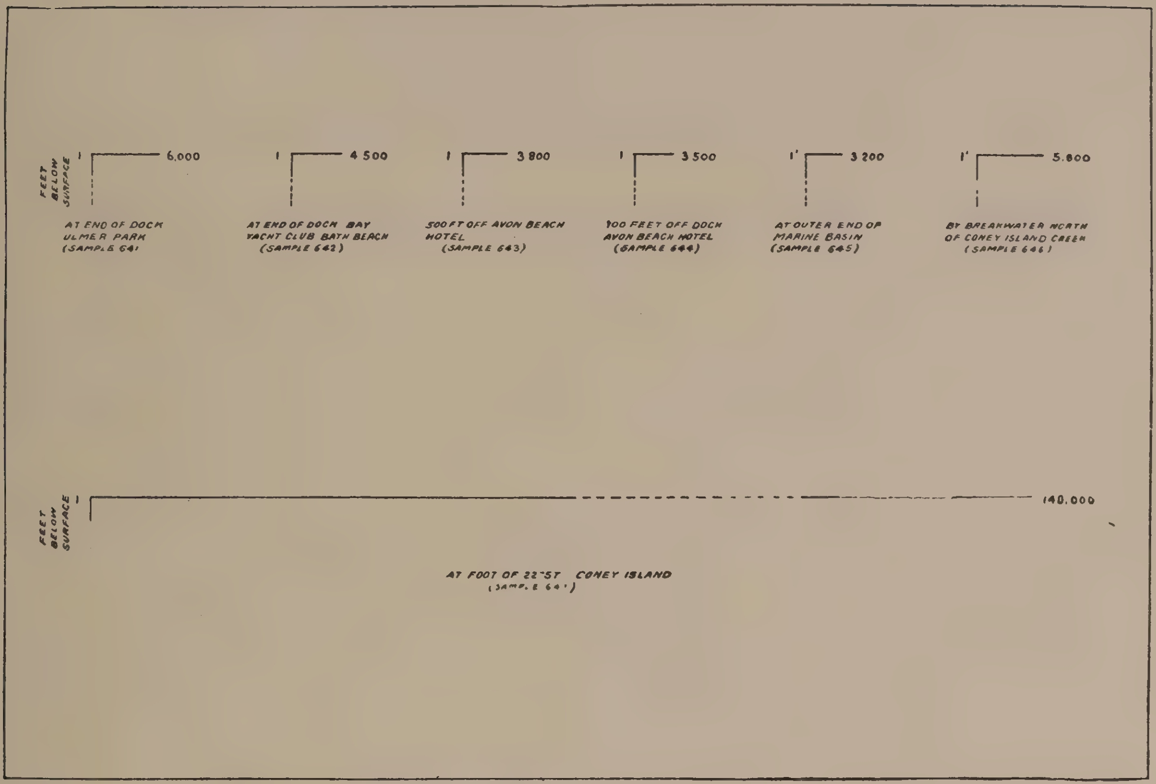


GRAVESEND BAY - CONEY ISLAND CREEK

BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE

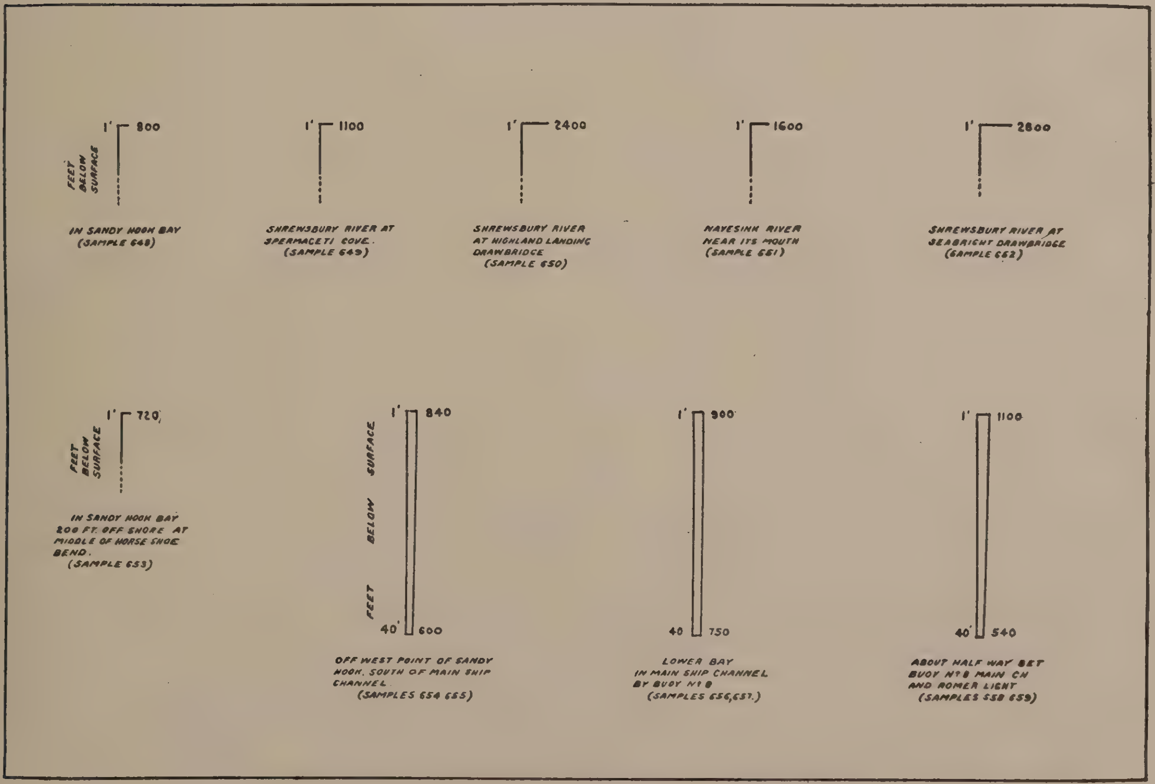
SAMPLES COLLECTED JULY 9TH '09

FIG. 53



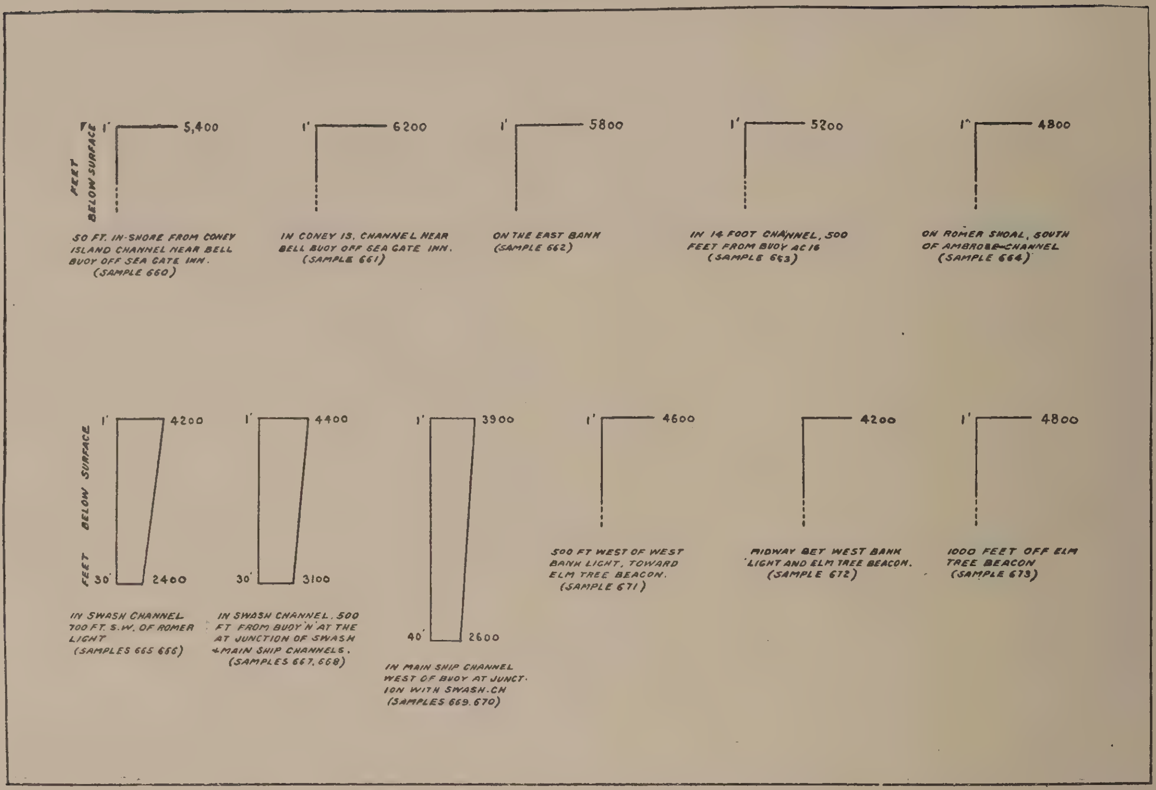
GRAVESEND BAY
BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED JULY 10TH '09

FIG. 54



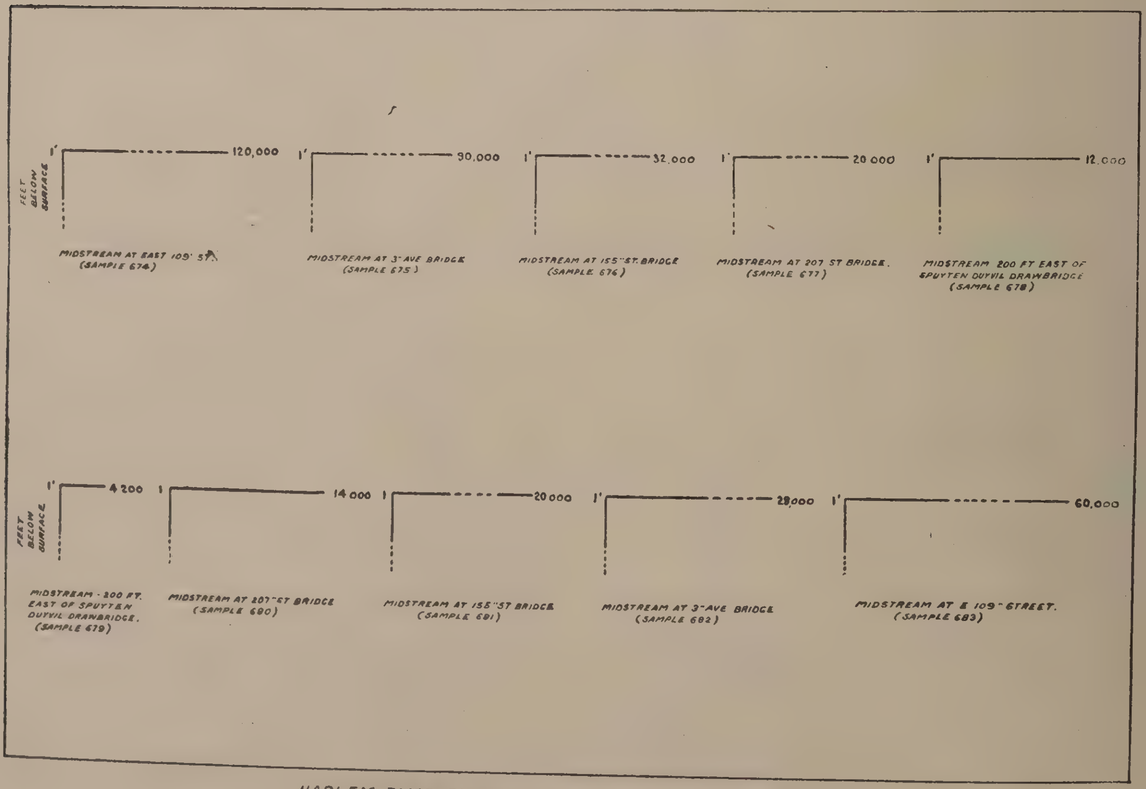
SANDY HOOK BAY - SHREWSBURY RIVER AND LOWER NEW YORK BAY
BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED JULY 13TH 1909

FIG. 55



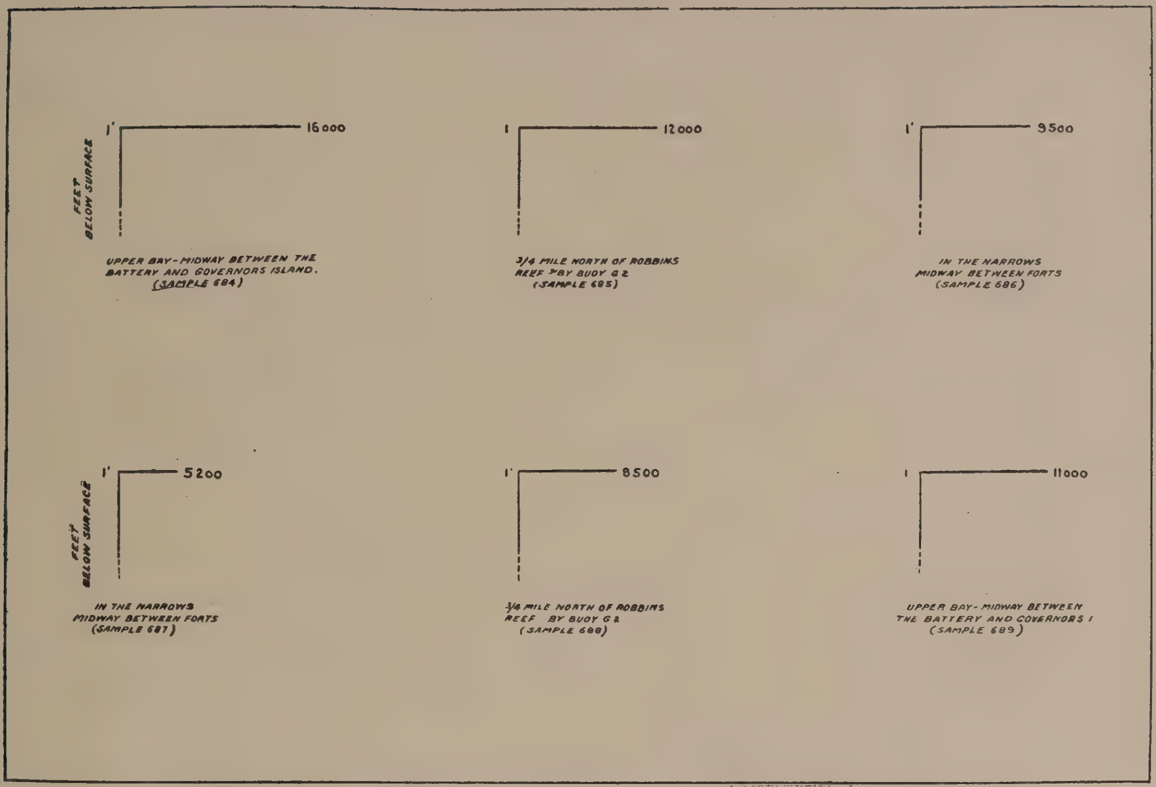
ACROSS LOWER N.Y. BAY - CONEY IS. TO ELM TREE BEACON
BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED JULY 14TH 1909

FIG. 56



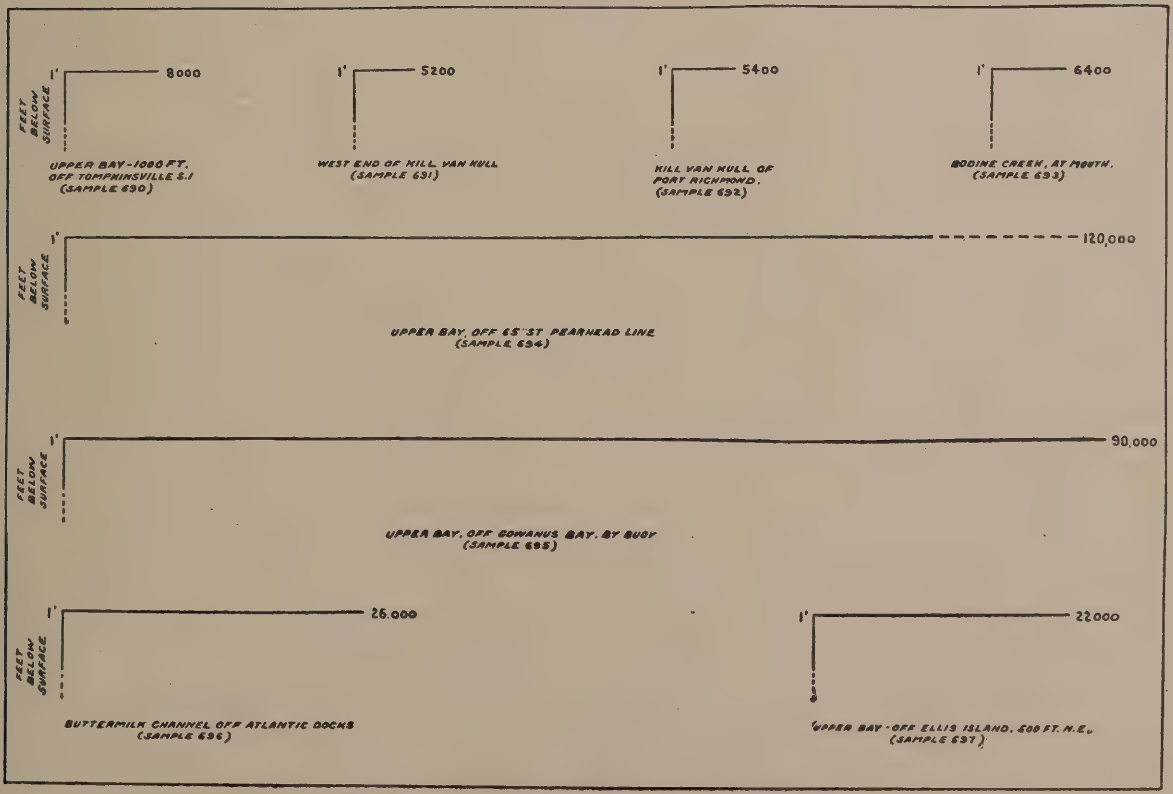
HARLEM RIVER-FROM HELL GATE TO SPUYTEN DUYVIL
BACTERIA PER C.C IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED JULY 15TH 1909

FIG. 57



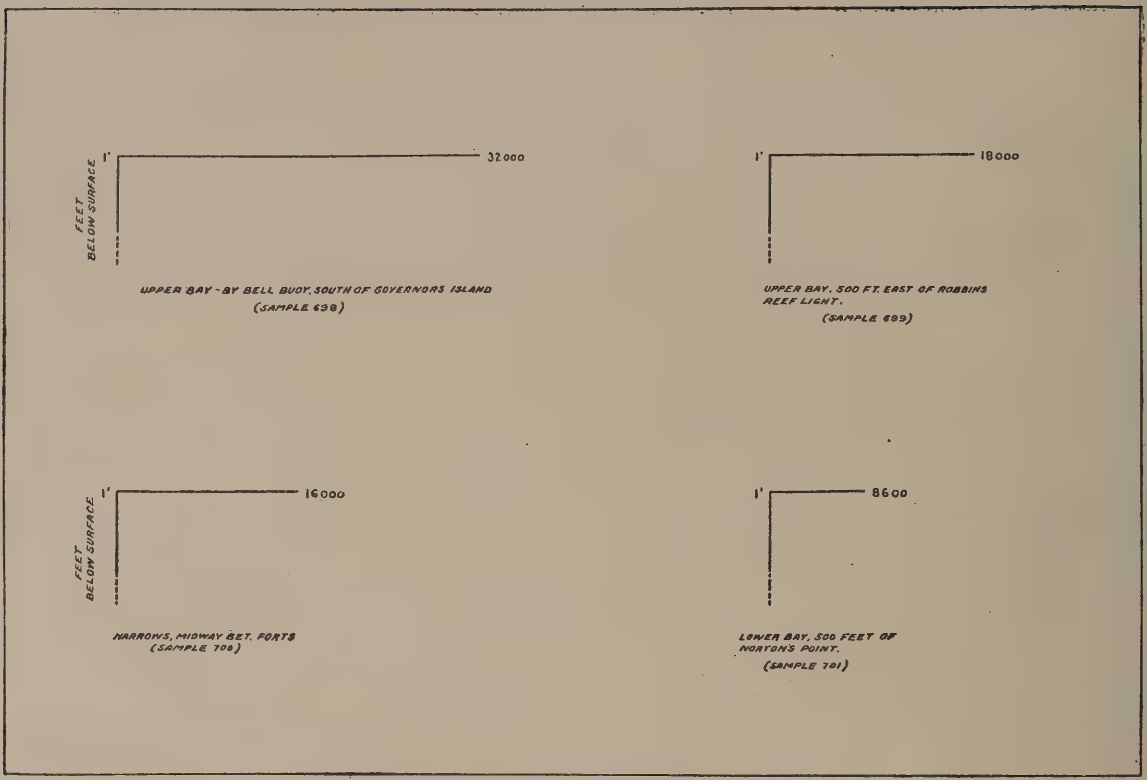
UPPER BAY FROM BATTERY TO THE NARROWS
BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED JULY 16TH 1909

FIG. 58



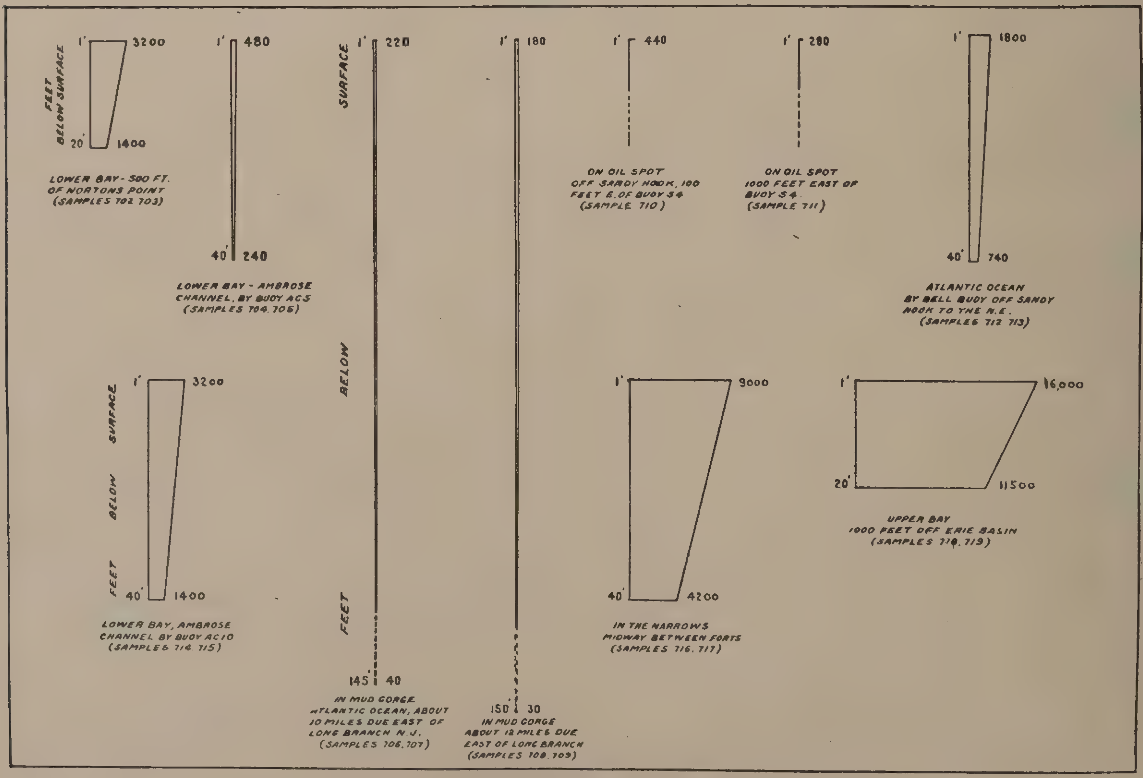
KILL VAN KULL AND UPPER BAY (EAST SIDE.)
BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED JULY 17TH 1909

FIG. 59



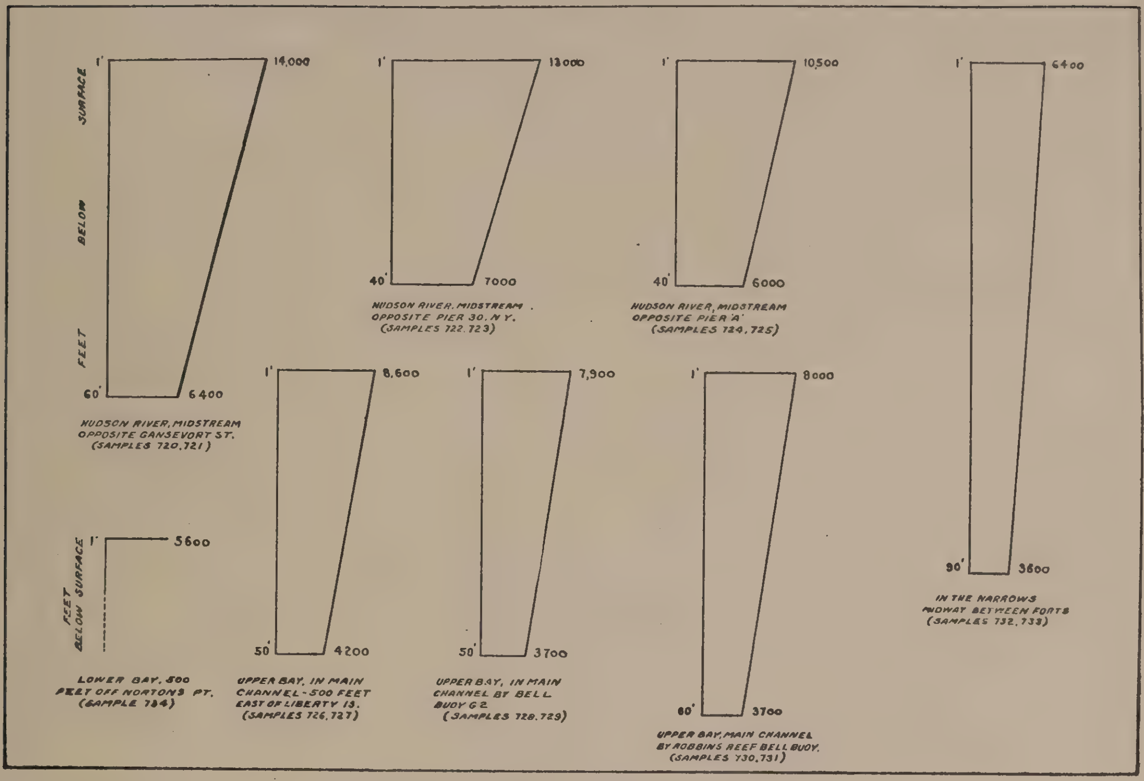
GOVERNORS ISLAND TO CONEY ISLAND
BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED, JULY 20TH 1909

FIG. 60



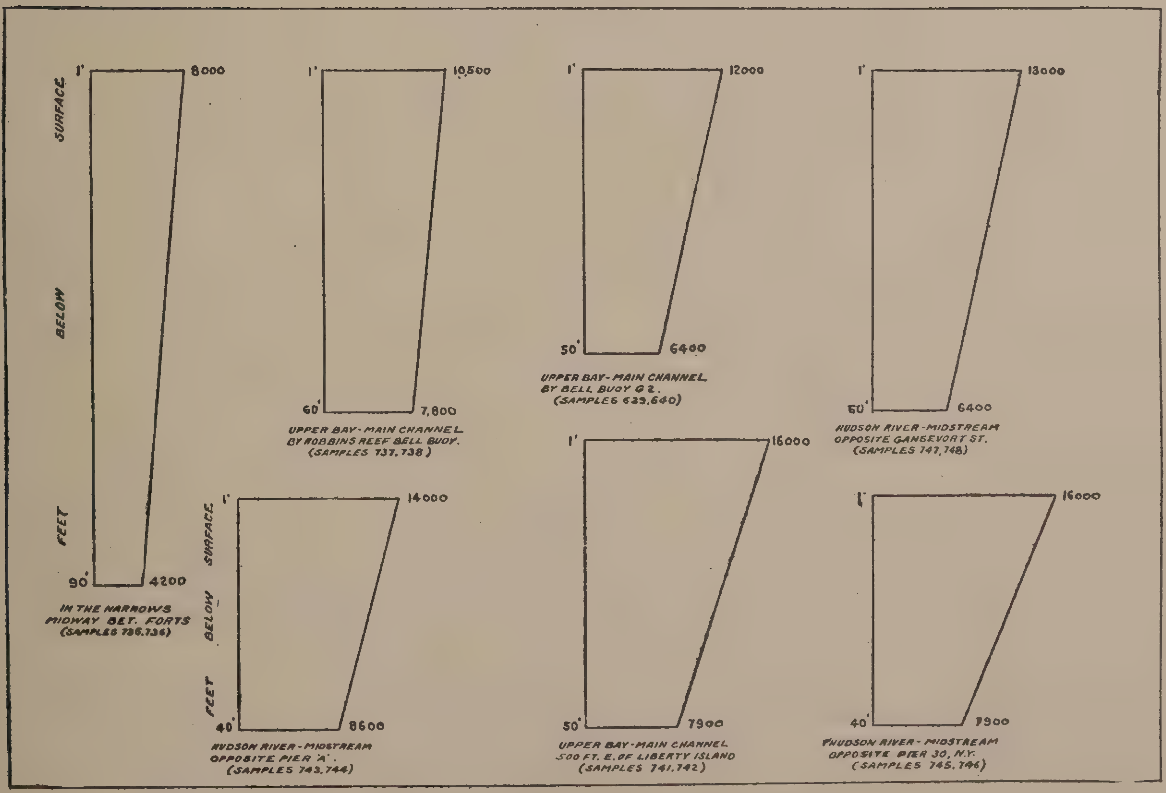
ATLANTIC OCEAN — NEW YORK BAYS
BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED JULY 21ST 1909

FIG. 61



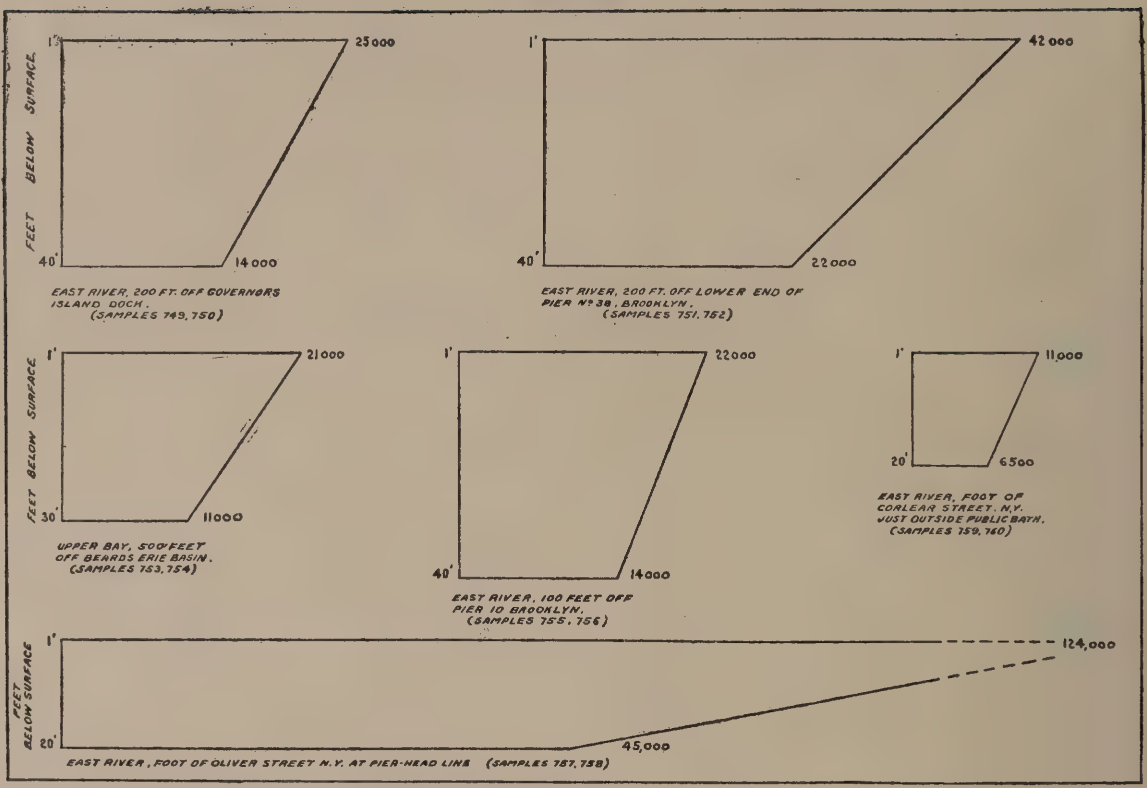
HUDSON RIVER TO CONEY ISLAND
BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED JULY 22ND '09

FIG. 62



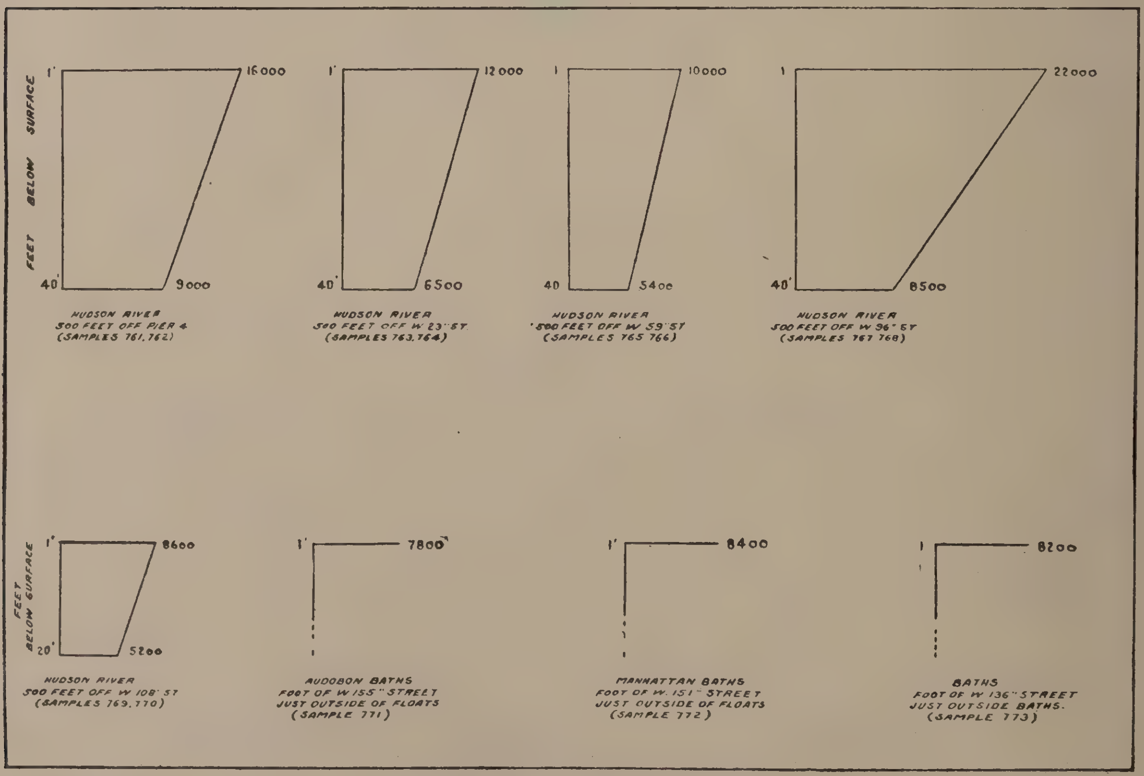
UPPER BAY - FROM NARROWS TO HUDSON RIVER
BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED JULY 22ND 1909

FIG. 63



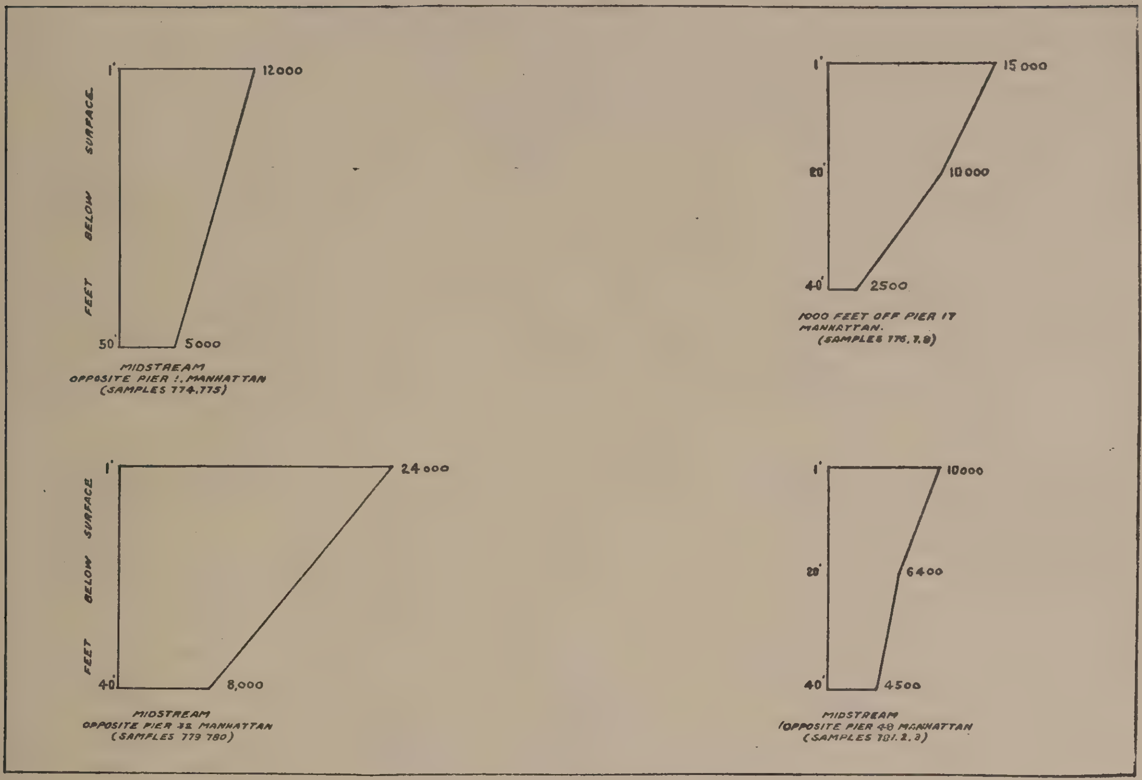
ERIE BASIN TO CORLEARS HOOK-EAST RIVER
BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED JULY 24TH 1909

FIG. 64



HUDSON RIVER - BATHING BEACHES
BACTERIA PER C C IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED JULY 26TH 1909

FIG. 65

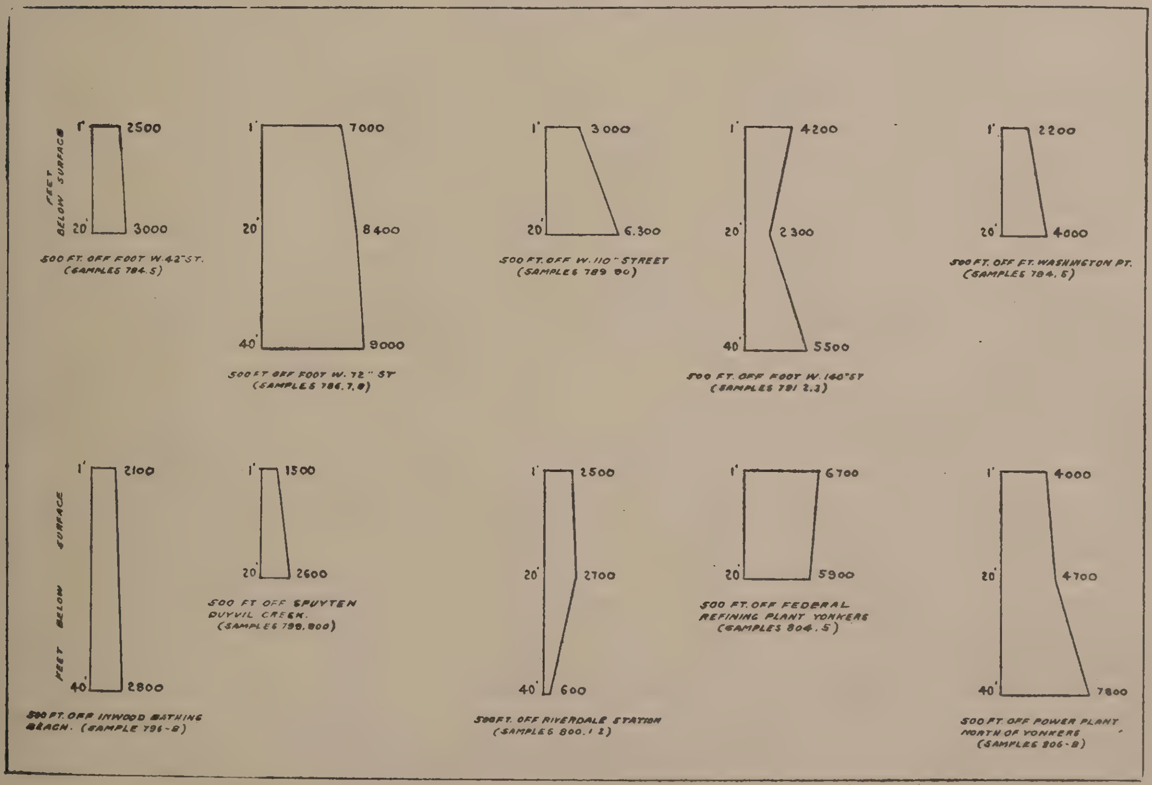


HUDSON RIVER, NEAR MOUTH

BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE

SAMPLES COLLECTED AUG. 19TH 1909

FIG. 66

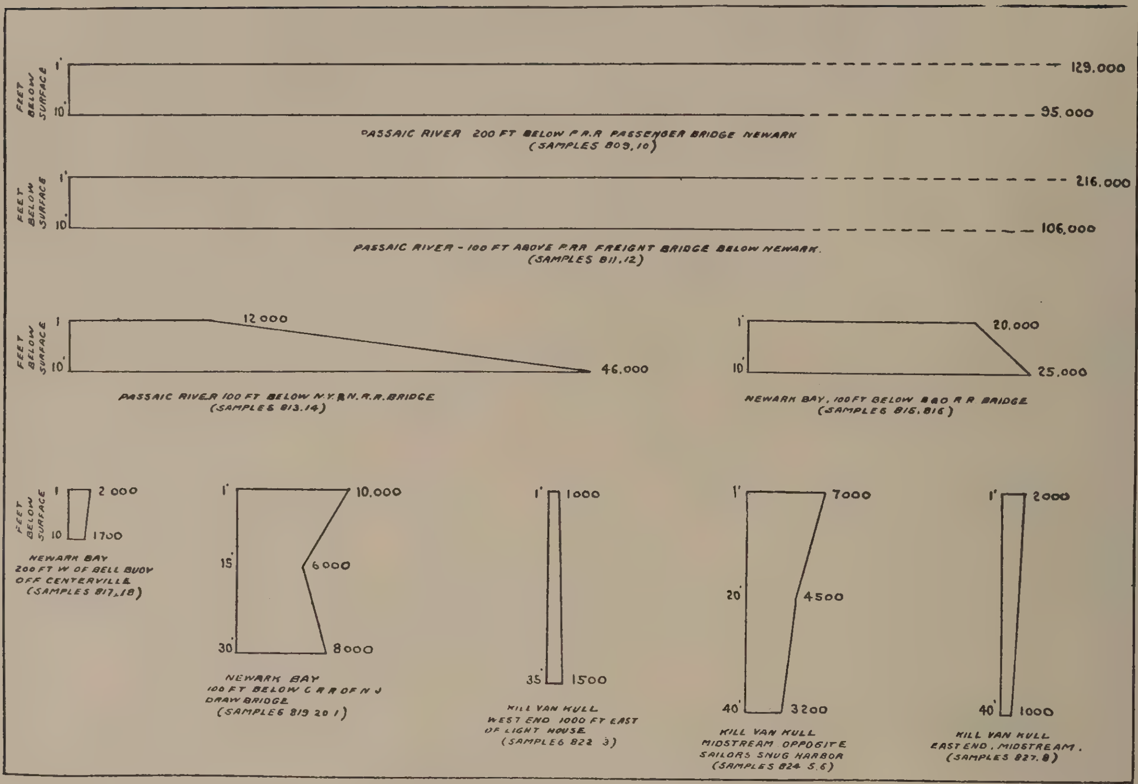


HUDSON RIVER - 42ND ST. TO YONKERS

BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE

SAMPLES COLLECTED SEPT. 7TH 1909

FIG. 67

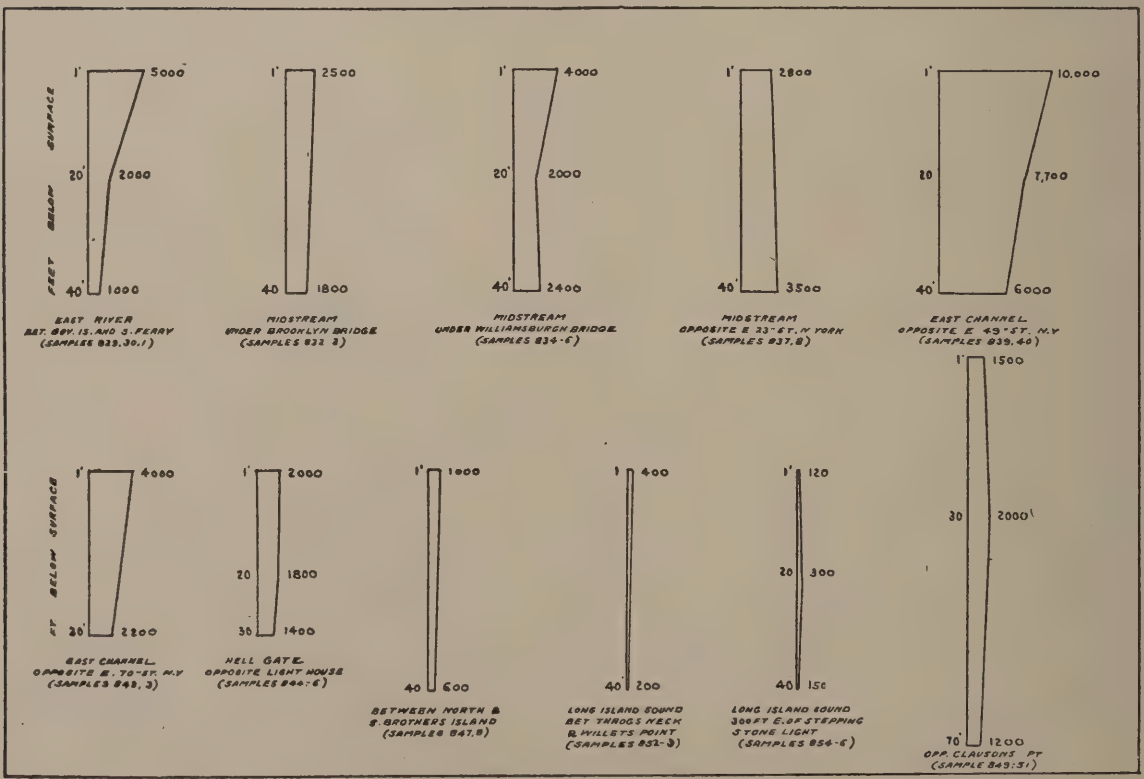


PASSAIC RIVER-NEWARK BAY

BACTERIA PER C C IN WATER AT DIFFERENT DEPTHS BELOW SURFACE

SAMPLES COLLECTED SEPT. 8TH 1909

FIG. 68

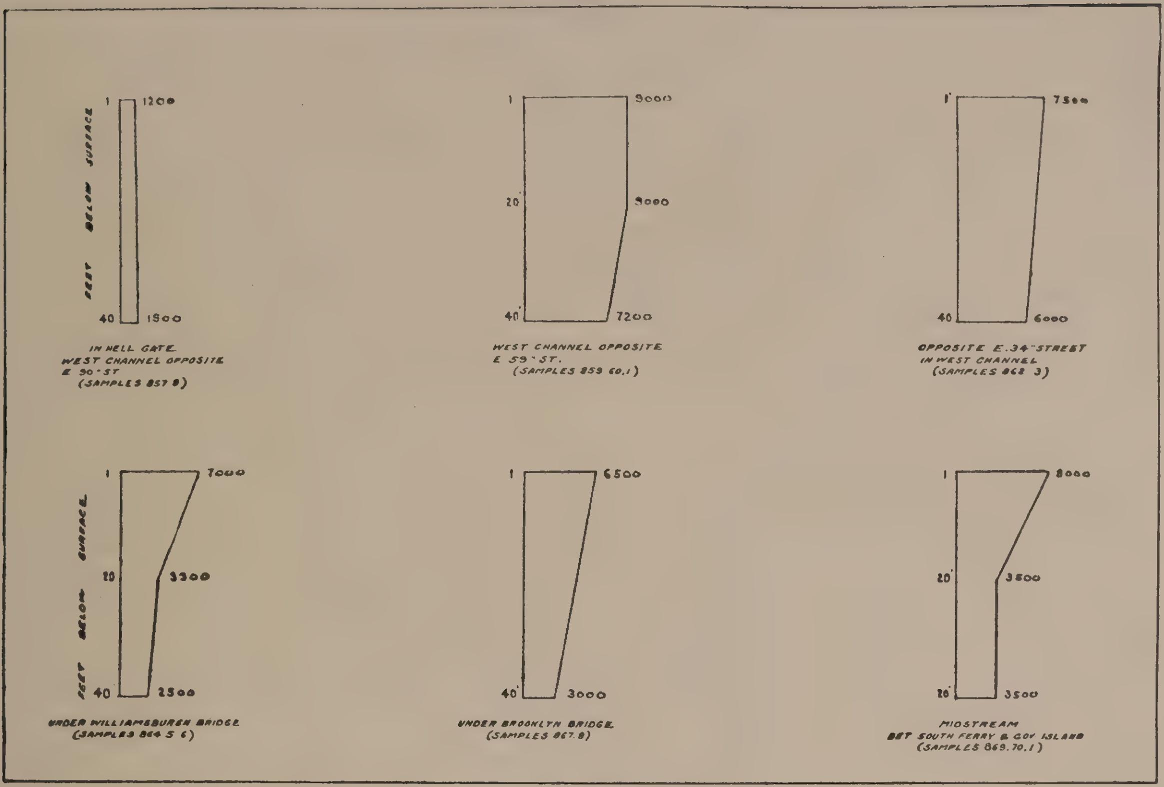


EAST RIVER + L. IS. SOUND

BACTERIA PER C.C IN WATER AT DIFFERENT DEPTHS BELOW SURFACE

SAMPLES COLLECTED SEPT 9TH 1909

FIG. 69

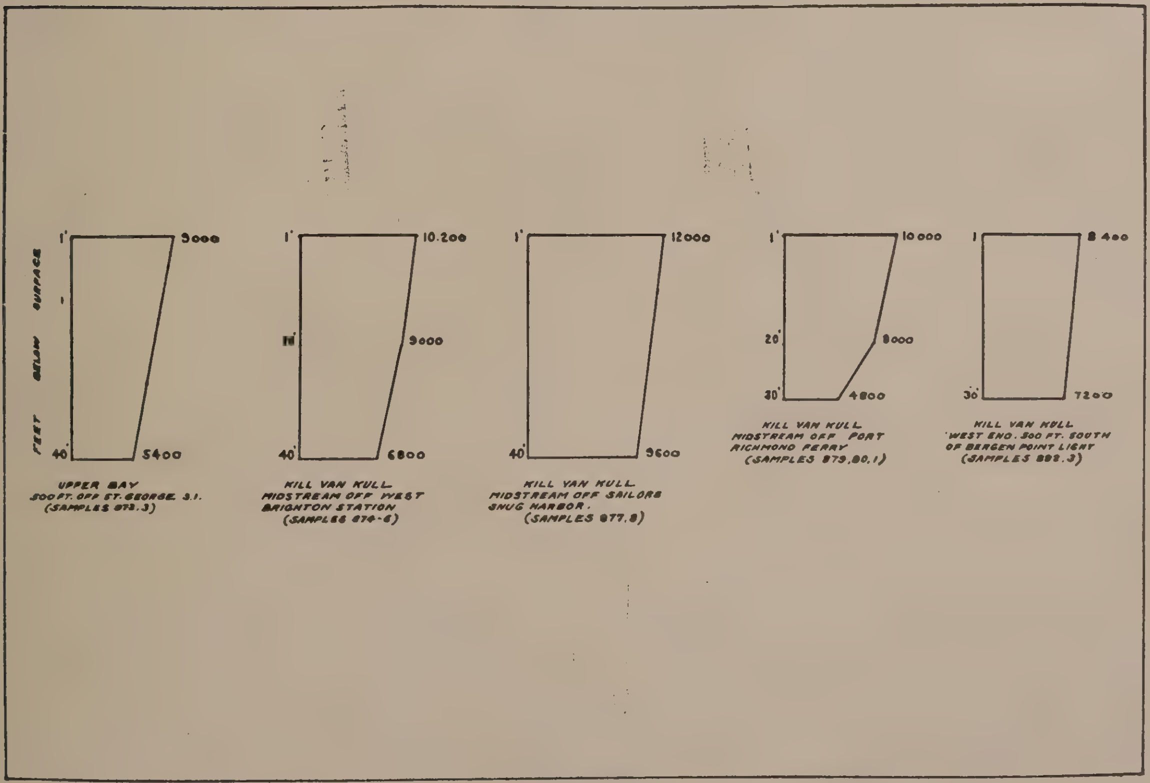


EAST RIVER

BACTERIA PER C C IN WATER AT DIFFERENT DEPTHS BELOW SURFACE

SAMPLES COLLECTED SEPT 10TH 1909

FIG. 70

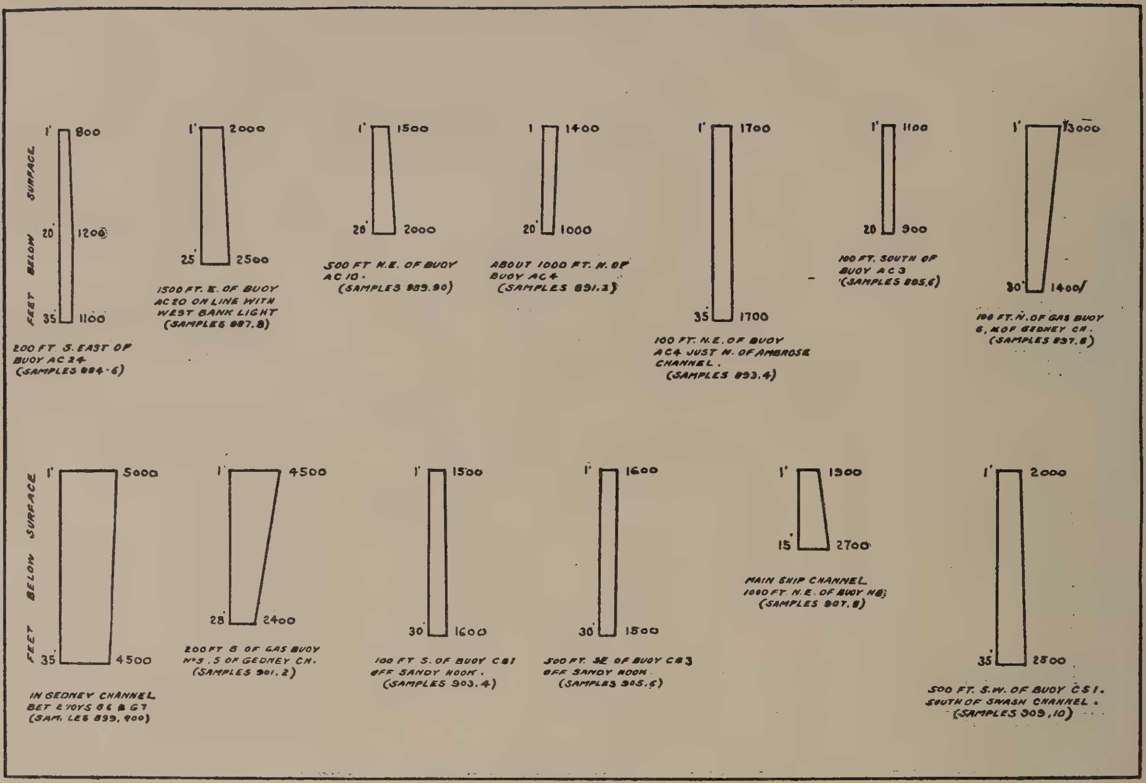


KILL VAN KULL

BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE

SAMPLES COLLECTED SEPT 11TH 1909

FIG. 71

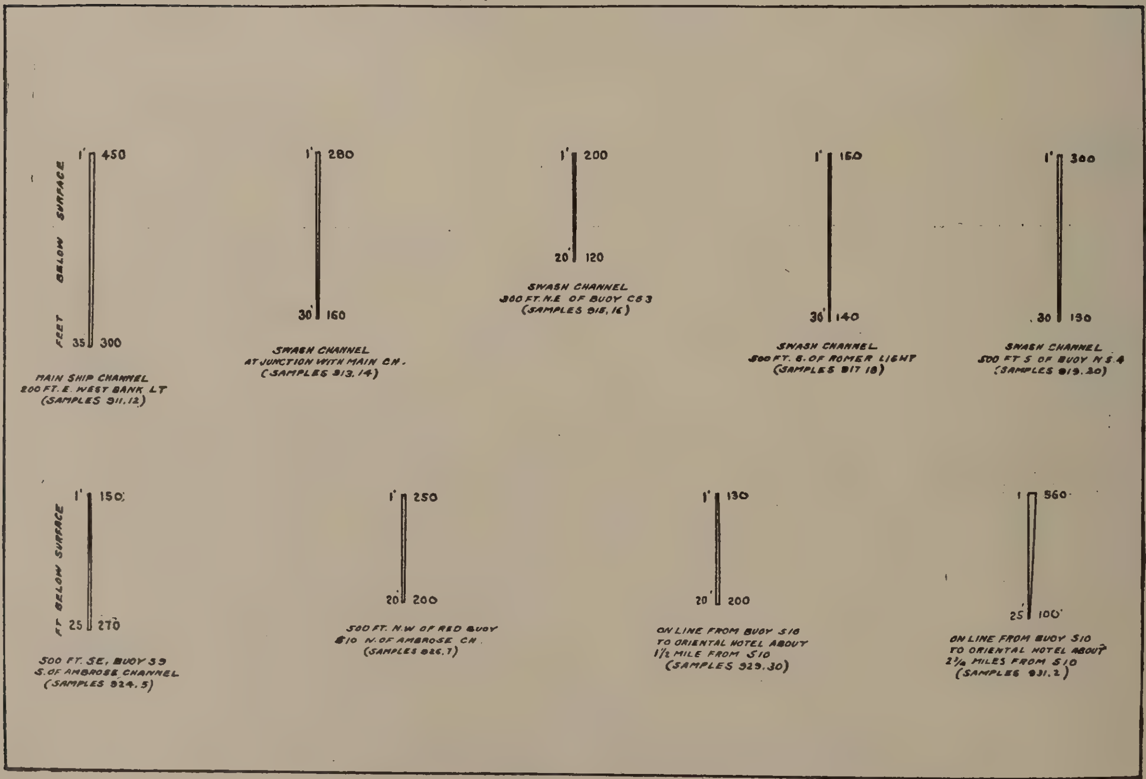


LOWER BAY

BACTERIA PER C.C IN WATER AT DIFFERENT DEPTHS BELOW SURFACE

SAMPLES COLLECTED SEPT. 13TH 1909

FIG. 72

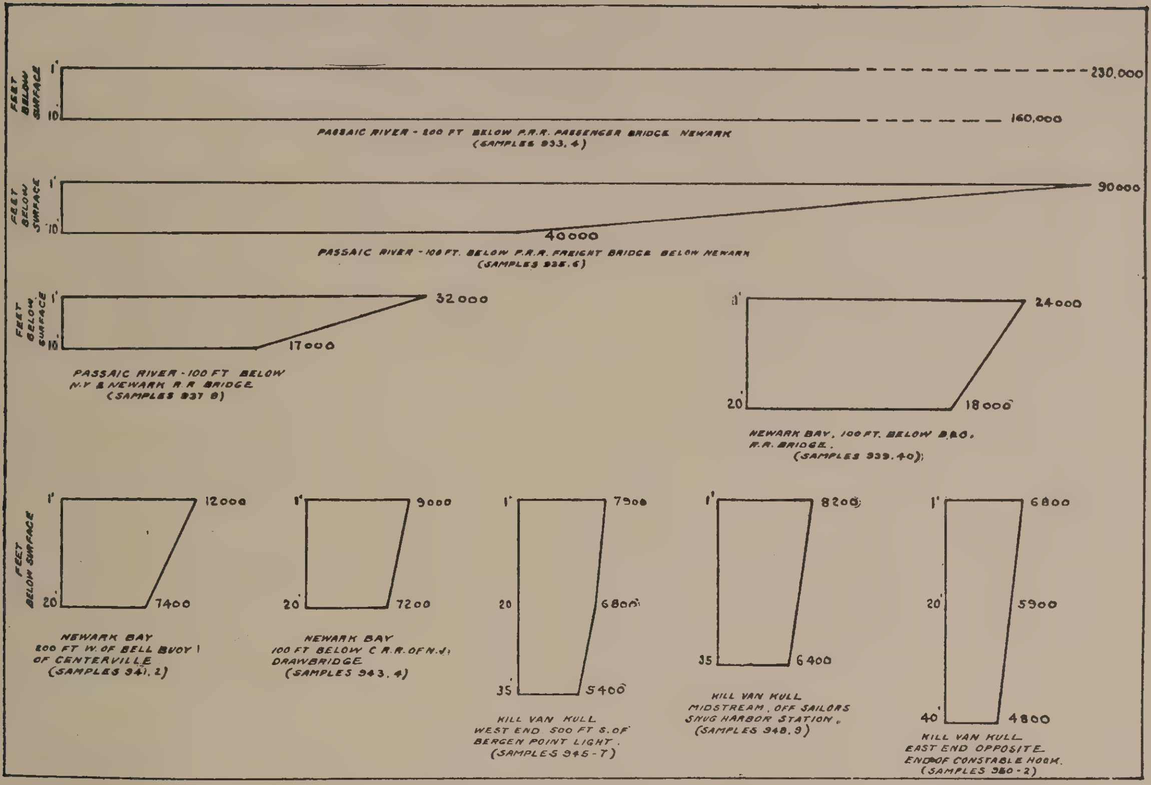


LOWER BAY

BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE.

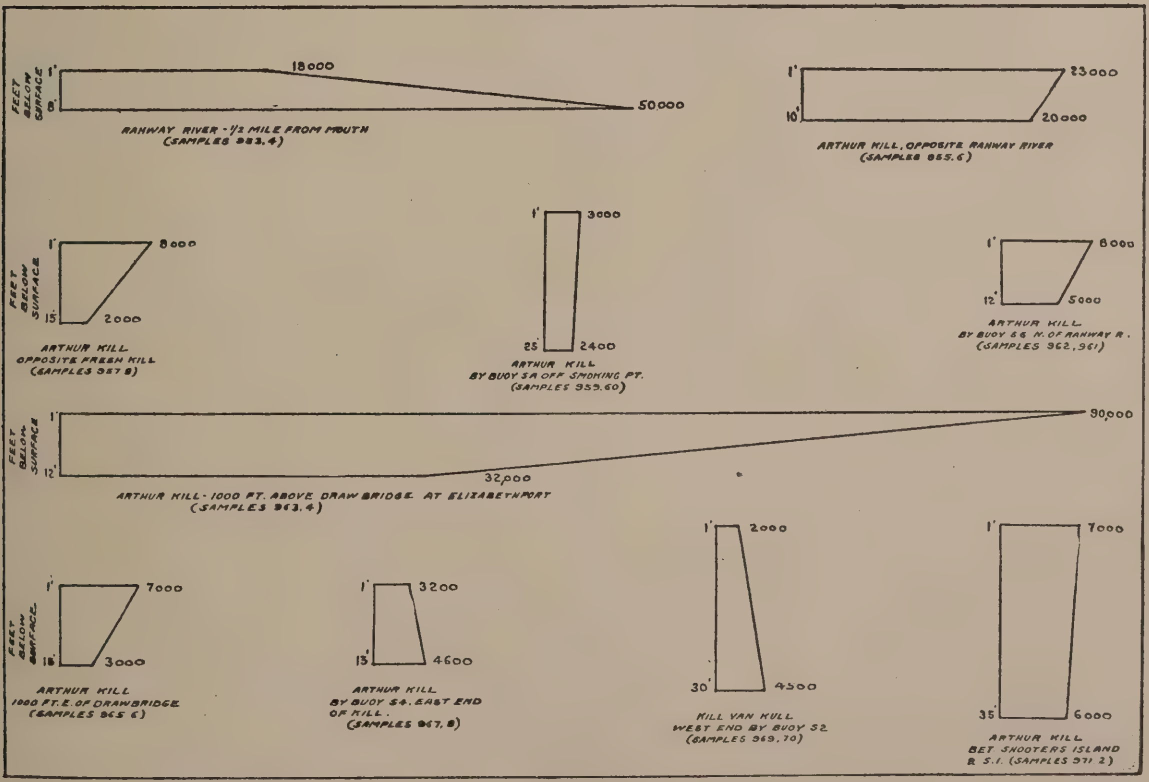
SAMPLES COLLECTED SEPT. 14TH 1909

FIG. 73



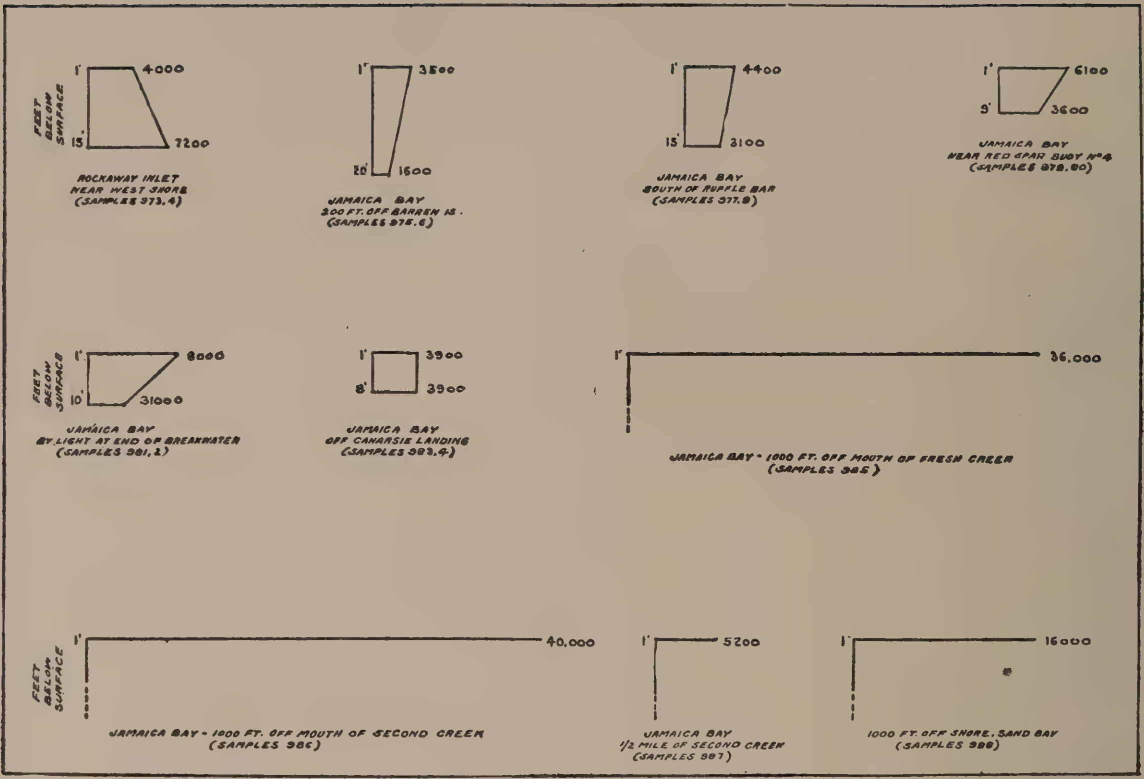
PASSAIC RIVER - NEWARK BAY - KILL VAN KULL
BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED SEPT. 15TH 1909

FIG. 74



ARTHUR KILL
BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED SEPT. 16TH 1909

FIG. 75

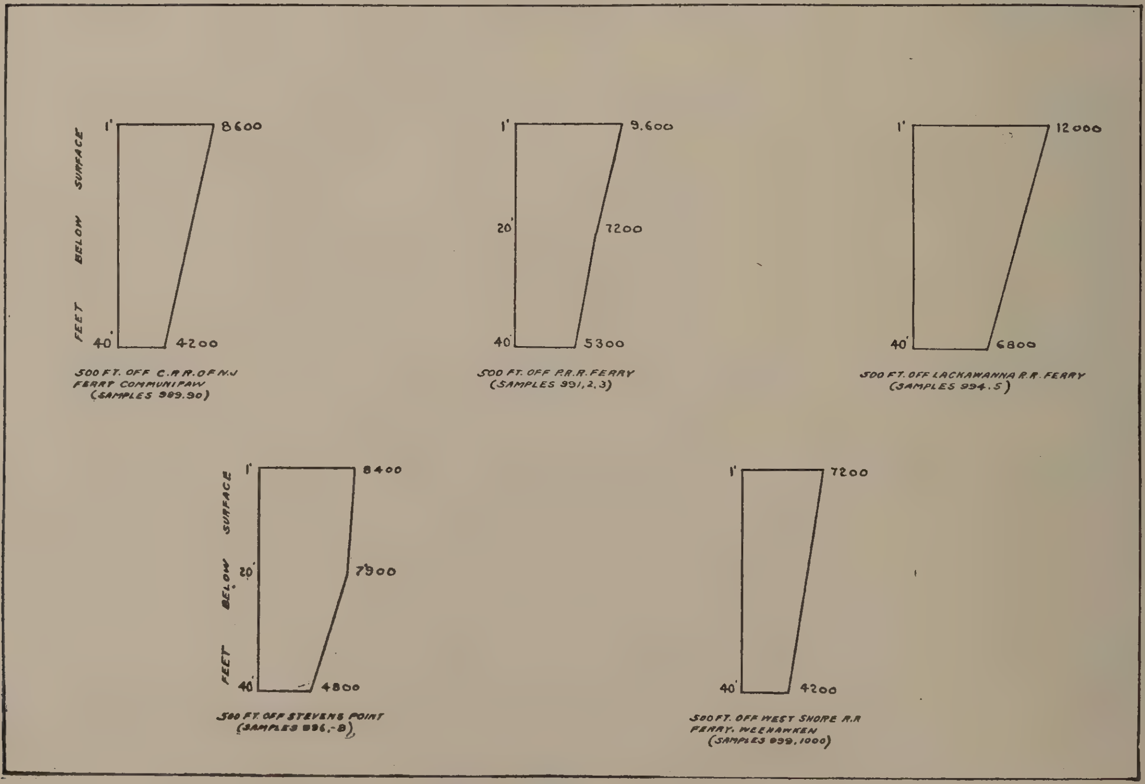


JAMAICA BAY

BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE.

SAMPLES COLLECTED SEPT. 17TH 1909

FIG. 76

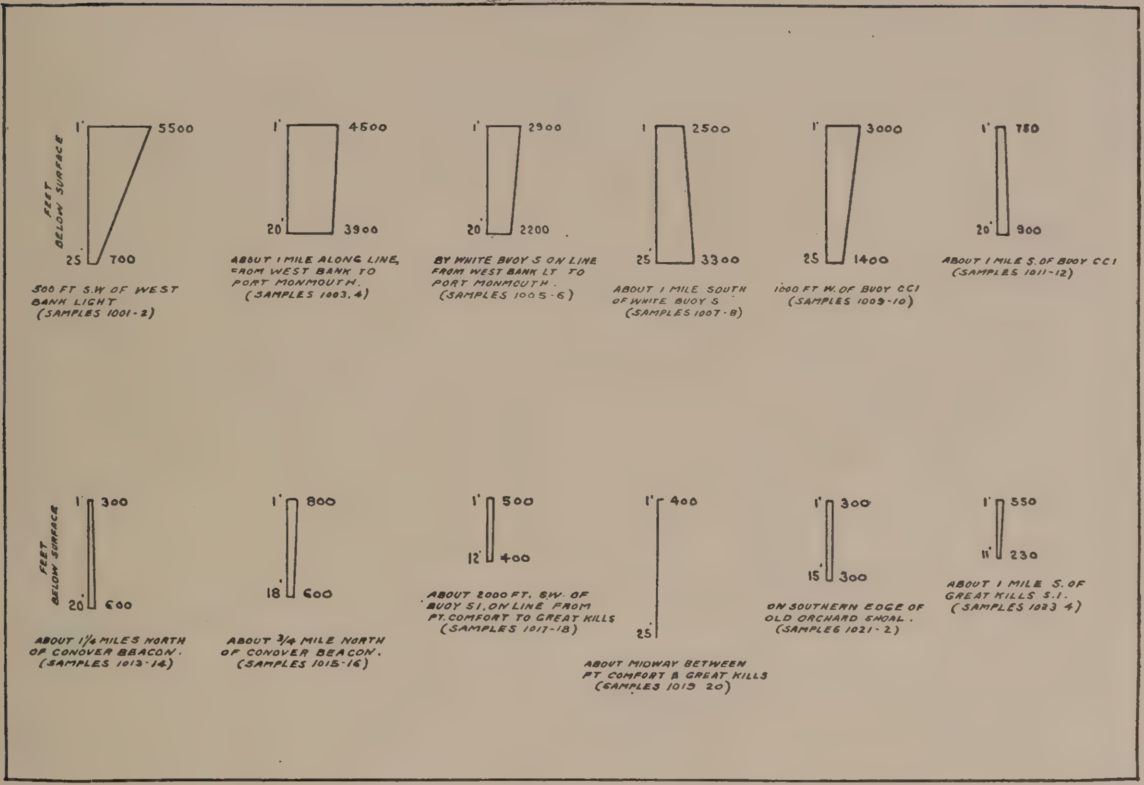


HUDSON RIVER - N. JERSEY SIDE.

BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE.

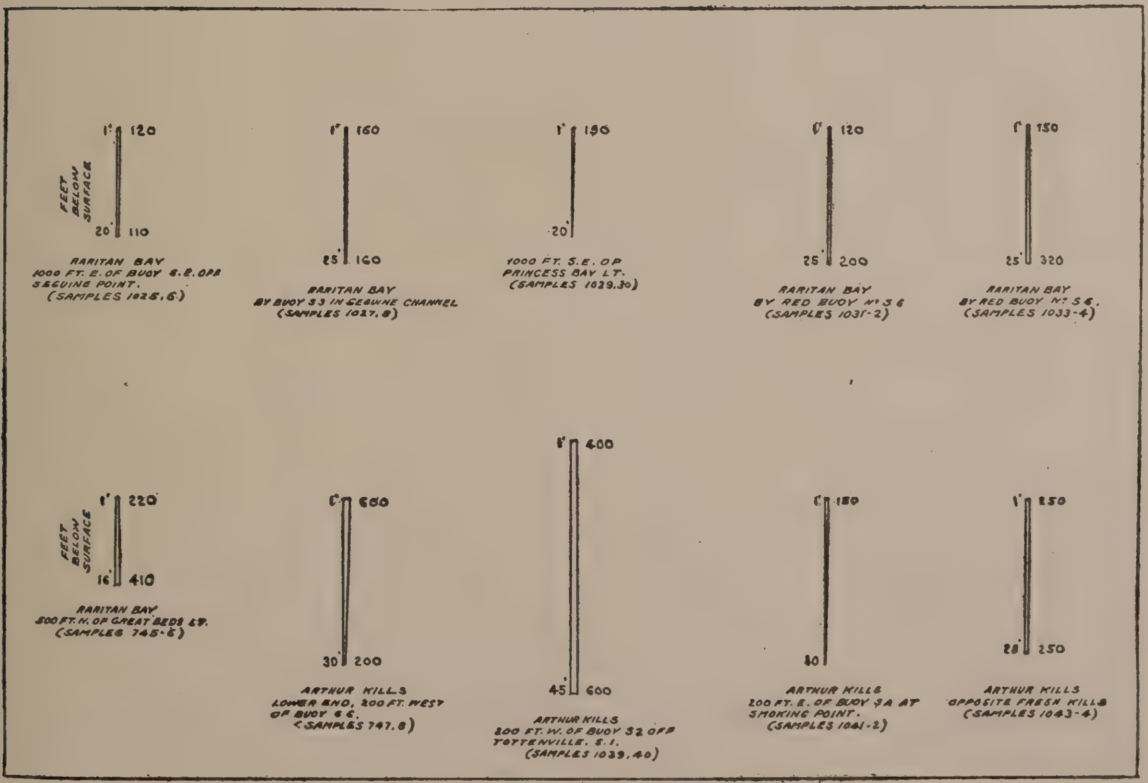
SAMPLES COLLECTED SEPT. 18TH 1909

FIG. 77



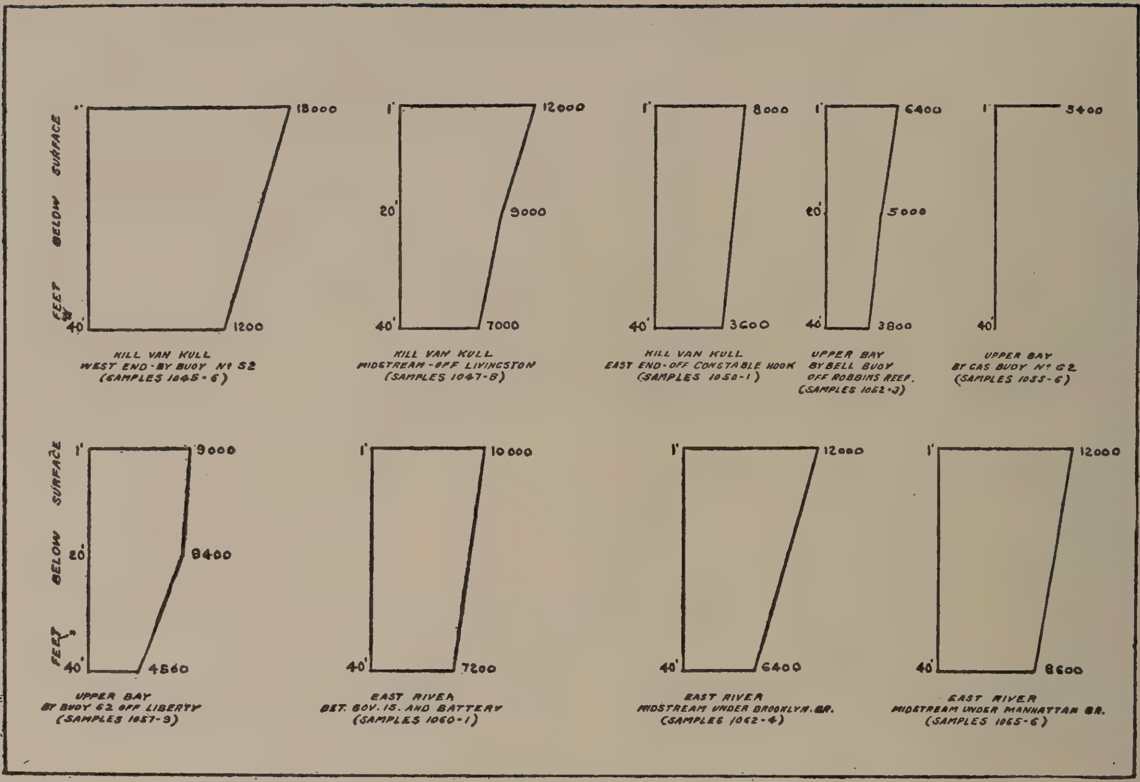
LOWER BAY
BACTERIA PER C.C IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED SEPT 20TH 1909

FIG. 78



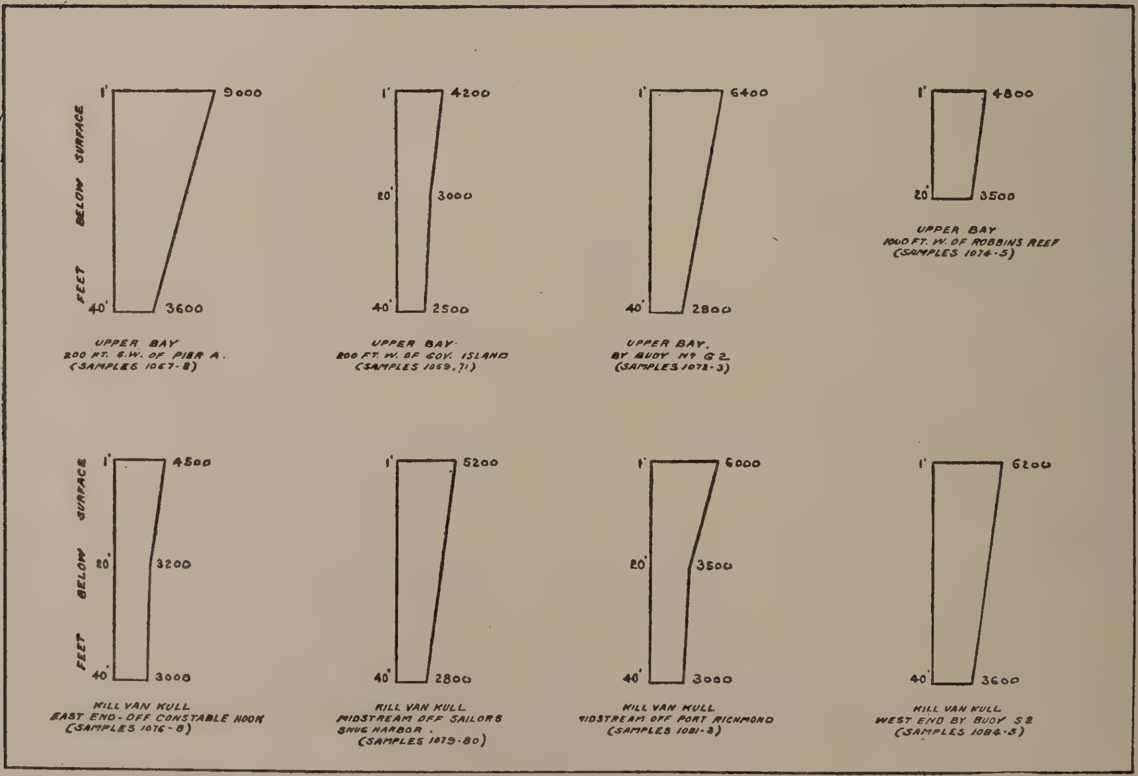
RARITAN BAY - ARTHUR KILLS
BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED SEPT. 21ST 1909

FIG. 79



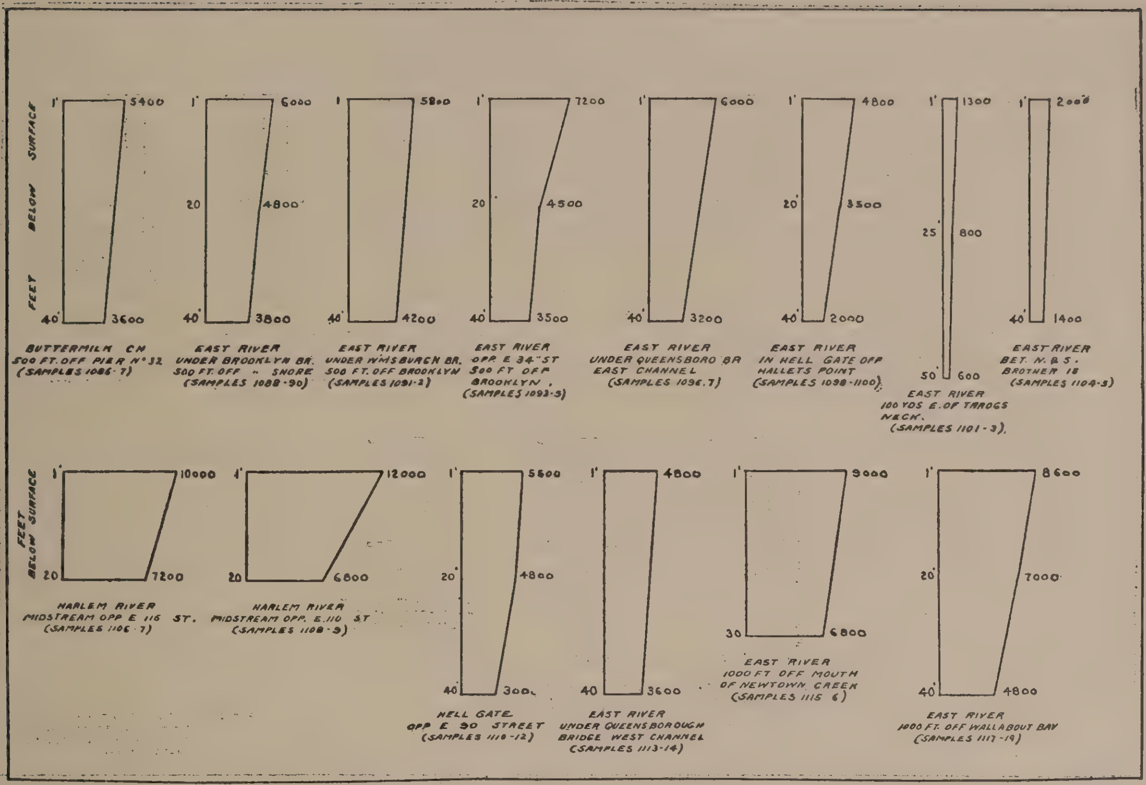
KILL VAN KULL - UPPER BAY - EAST RIVER
BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED SEPT 23RD 1909

FIG. 80



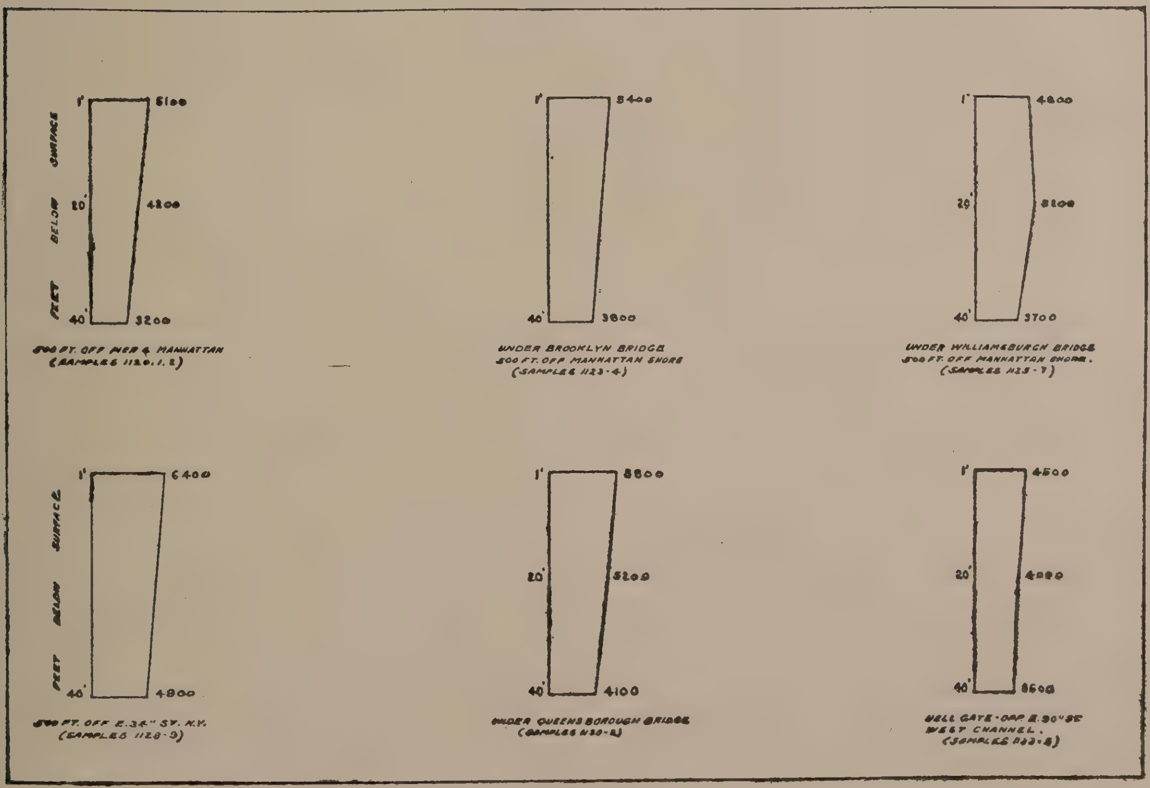
UPPER BAY - KILL VAN KULL
BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED SEPT. 30TH 1909

FIG. 81



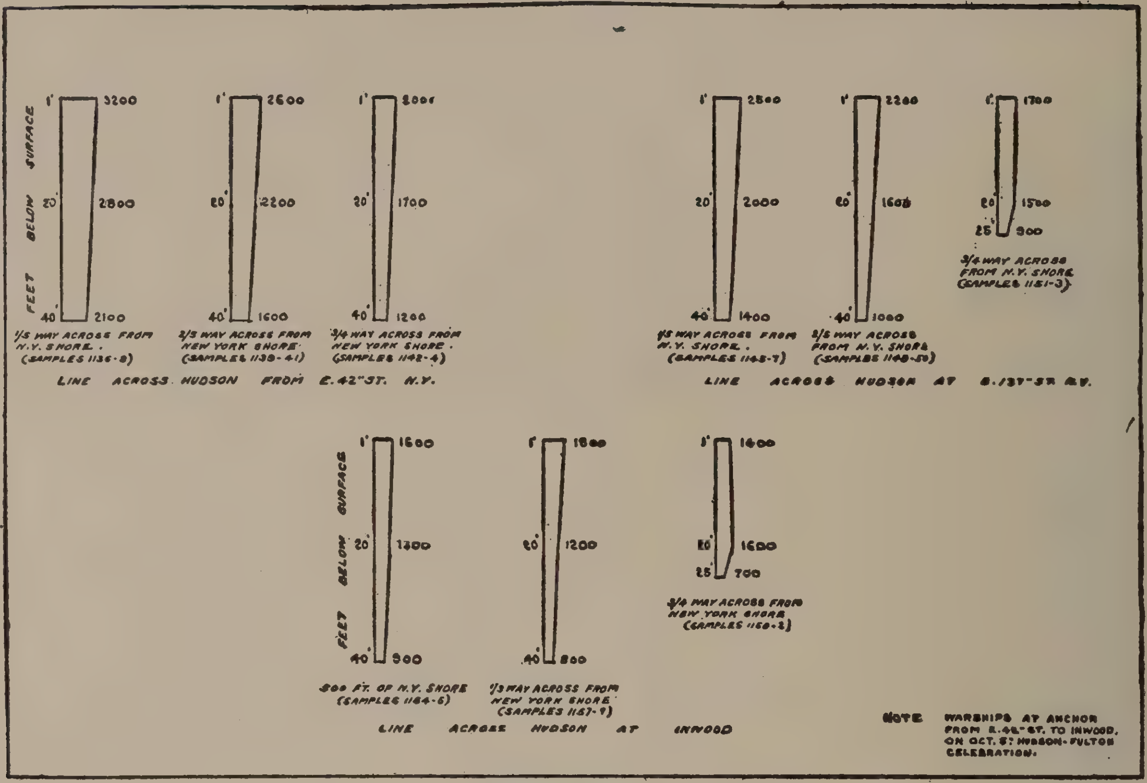
EAST RIVER-HARLEM RIVER
BACTERIA PER C.C IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED OCT 1ST 1909

FIG. 82



EAST RIVER
BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE
SAMPLES COLLECTED OCT. 2ND 1909

FIG. 83



NOTE WARSHIPS AT ANCHOR FROM E.42ND ST. TO INWOOD, ON OCT. 5: HUDSON-FULTON CELEBRATION.

HUDSON RIVER

BACTERIA PER C.C. IN WATER AT DIFFERENT DEPTHS BELOW SURFACE

SAMPLES COLLECTED OCT. 5TH 1909

CHAPTER III

DISSOLVED OXYGEN IN THE WATER

GENERAL INTRODUCTION TO THE DISSOLVED OXYGEN WORK

The value of the oxygen analyses here reported depends on the fact that when sewage is discharged into either land or sea water, a certain amount of the dissolved oxygen in the water is used up by the processes of nature in converting the decomposable substances into stable compounds. By determining the amount of dissolved oxygen present in a sample of polluted water, information can be obtained concerning the burden of contamination which is being imposed.

Method of Stating Results

The extent to which the oxygen is being exhausted is determined by comparing the amount of oxygen found with the quantity which would be present if the water was saturated with oxygen. This assumes that if it were not for the sewage the water would be saturated. Numerous analyses of unpolluted tributaries of the harbor and of the sea have proved this assumption to be correct. Considering saturation to be 100 per cent, the amount of oxygen found can be conveniently stated as a percentage.

The amount of oxygen present when the water is saturated varies with the salinity and temperature of the water. There is danger that a wrong inference may be drawn if this is not kept in mind. To avoid confusion, it is desirable to consider the actual amount of oxygen present, as well as the percentage, or relative amount which exists. In the Commission's tables of dissolved oxygen, these two methods of stating the results are employed side by side.

Reasons for Using the Oxygen Test

The reasons which led the Commission to employ dissolved oxygen determinations as an index of pollution in place of the more usual analyses for nitrogen in various forms follow:

First. It was desirable to employ an index of pollution which would strike as near as possible to the heart of the subject. The determination of dissolved oxygen accomplishes this result much more nearly than do analyses for the nitrogen compounds. Determinations of albuminoid and free ammonia, nitrites and nitrates, are chiefly useful in indicating the amount and condition of the polluting matter, whereas the dissolved oxygen test shows the effect which the polluting matter has produced.

Second. No method of proved reliability was available for the determination of nitrates in the harbor waters. By many persons nitrates were believed not to exist in sea water or in mixtures thereof and methods commonly employed for the determination of nitrates in land water failed when applied to the waters of New York harbor. Nitrites were sometimes present in excessive amount. Apparently conditions were occurring in these waters which were unlike the conditions which accompany the disappearance of sewage matters when discharged into inland rivers and lakes, and until this subject could be studied by the aid of reliable analyses, it was not desirable to place much importance upon the presence or absence of those nitrogen compounds which could be determined.

Third. The difficulty of interpreting the analytical results would be simplified by reducing the variety of tests to the lowest terms. This could be admirably accomplished by employing dissolved oxygen alone.

Fourth. If a single reliable field method could be employed, it would greatly increase the number of samples which could be analyzed over the number which it would be possible to examine by more than one test. The range of conditions thus capable of study would be a great advantage.

It was essential that the method of analysis employed would be susceptible of check, so that no substantial error would occur either in the actual examination of the sample or in its interpretation.

If possible, the method employed should be suitable for use in the field so that a boat could be fitted up and tests made in large number at minimum cost. This would obviate the inconvenience attending the transportation of samples and have the advantage of preventing any change taking place in the quality of the water between the time of collecting and analyzing the sample.

Rate of Replenishment of Oxygen from the Air

In interpreting the data, some fundamental considerations should be kept carefully in mind. The significance to be attached to a given amount of dissolved oxygen in New York harbor water is not as apparent as might at first appear.

The oxygen found is due to the amount originally present, minus the amount which has been absorbed through pollution by sewage and other wastes, plus the amount which has been taken up from the atmosphere. The rate of absorption of oxygen by water plays an important and generally disregarded part in investigations of this character. It is sometimes assumed that no absorption takes place from the air. At other times, it is taken for granted that the rate at which the oxygen is absorbed by the water is uniformly the rate at which it is taken up when no oxygen whatever is initially present. The less oxygen there is present in the water to start with, the more rapidly will the oxygen be replenished from the atmosphere. The larger the amount present, the slower is the rate of replenishment. The practical effect of the difference in rate of replenishment of oxygen from the atmosphere is that a much nearer balance between the supply and demand of oxygen in water takes place than would otherwise occur.

In interpreting the data, it must not be inferred that one sample of water is twice as bad as another because it contains only half as much oxygen. It may be several times as bad. Nor does it follow that because the discharge of a certain amount of sewage produces a definite reduction in the dissolved oxygen that twice as much sewage would produce twice this effect.

METHOD OF ANALYSIS

The procedure adopted for the determination of the oxygen depended upon the absorption of the oxygen by ferrous sulphate in the presence of an alkali, the amount of ferrous sulphate not acted upon by the oxygen being then determined by acidifying and titrating with potassium permanganate. This method, sometimes called the Albért-Lévy method,* was believed to have been substantially that employed by Letts and Adeney in the investigations described by them in the Fifth Report of the Royal Commission on Sewage Disposal of Great Britain, Appendix VI. The apparatus, as well as most of the details of technique, were such as had been seen by one of the members of the Metropolitan Sewerage Commission (Soper) in Ireland and described by Letts and Adeney in the Fifth Report. The use of permanganate has, however, been declared by Professor Letts to be unreliable and bichromate of potassium alone capable of giving accurate results with sewage effluents and sea water. Inasmuch as the accuracy of the work done by the Metropolitan Sewerage Commission depends upon the question whether permanganate is, or is not, capable of giving accurate results, the point raised by Professor Letts, who is a recognized authority on the subject, requires careful attention in this place.

In a description by Professor Letts of the dissolved oxygen method employed by him,† he says, "The use of permanganate as an oxidizing agent may, in certain cases, be one of the most serious" errors to which the process is exposed. In letters to the President of the Metropolitan Sewerage Commission and others, Professor Letts has pronounced a strong opinion against permanganate and in favor of bichromate of potassium when salt waters are being analyzed, calling attention to a paper by Letts and Blake* in which his belief in the inaccuracy attending the use of permanganate in the presence of sodium chloride is pointed out.

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*Albért Lévy, the "Annuaire de l'Observatoire Municipal de Montsouris," Paris, 1884.

†Fifth Report Royal Commission on Sewage Disposal of Great Britain," Appendix VI, pp. 221-226.

When the Metropolitan Sewerage Commission first considered the use of the method, it became apparent that bichromate of potash could not be used under the circumstances which would exist. The need was for a process which could be employed on small boats and sometimes in rough weather. The use of bichromate involved difficulties of technique which could not be overcome. In Professor Letts' words,† "Attention must be paid to the following details:

> "(1) A clear crystal of potassium ferricyanide, or fragments of such crystal, about the size of a shot (say ⅛-inch in diameter) is placed in a small beaker, and washed two or three times with distilled water. It is then dissolved in about 10 c. c. of the same liquid. Some of this (straw-colored) solution is drawn into a pipette with a fine capillary end, and a series of minute drops are placed by its means on a slab of milk glass. (A white tile is not so satisfactory, as it is liable to become stained after some time.) (2) In titrating, as large a drop as can be carried on a glass rod from the dish is jerked into one of the minute drops of the ferricyanide without touching the latter with the rod itself. The 'end reaction' is shown by there being no visible difference in color after an interval of two minutes between the drops thus made and a similar one formed of distilled water and the ferricyanide. The end reaction is very sharp, and with a little experience is determined by less than 0.03 c. c. of the bichromate solution (about 1 drop from a 10 c. c. burette). (3) Strong sunlight disturbs the end reaction in the case of polluted waters (probably by the well-known reducing effect of light on a ferric salt in presence of organic matter). This can be easily demonstrated by placing on the white glass slab two similar drops of the ferricyanide and the titrated mixture when the end reaction has just occurred—shading one (say with a pill-box lid) and exposing the slab to sunlight for a few minutes, when the unshaded drop becomes blue, while the shaded drop remains faintly yellow. This action is especially noticeable with polluted sea-water. The titration can be performed by artificial light—preferably incandescent electric light—the end reaction being very sharp. (4) As only 5 c. c. of the standard bichromate are required at maximum for each titration or standardization, a burette of this capacity and divided into twentieths of a cubic centimeter might be advantageous for very accurate work."

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*On a Simple and Accurate Method for Estimating the Dissolved Oxygen in Fresh Water, Sea Water, Sewage Effluents, etc." By Prof. E. A. Letts, D. Sc., Ph. D., and R. F. Blake, F. I. C., F. C. S., Queens College, Belfast. "Scientific Proceedings of the Royal Dublin Society," Vol. IX (N. S.), Part IV, No. 33. Published June 11, 1901.

†"Fifth Report Royal Commission on Sewage Disposal of Great Britain, Appendix VI, p. 223.

In order to adapt the method to the Commission's use, it was apparently necessary to use permanganate. There appeared to be no sufficient reason why permanganate should not be employed except for the presence of sodium chloride, and allowance could be made for this by making suitable blanks or controls. The titration with permanganate could be carried on under extremely adverse conditions of weather on any boat which the Commission was likely to use. Accordingly, Prof. Floyd J. Metzger, of Columbia University, was requested to make some experiments with the process. Professor Metzger advised an improved form of stopper for the Letts and Blake separatory funnel in order better to exclude air bubbles, recommended the use of sodium carbonate instead of ammonia to control the reaction and found no error in the employment of permanganate. Professor Metzger was then employed to make up the standard solutions as they were required, and the actual work of analysis was placed in the hands of Payn B. Parsons, A.M., M.D., under the direction of the President.

Professor Gill's Criticism

After analyses had been made in considerable number, it seemed desirable to make further tests of the accuracy of the method. Professor Gill of the Massachusetts Institute of Technology was then invited to examine the work performed and subject it to severe criticism.

On November 15, 1909, Professor Gill reported that the method which he saw carried out by the Commission left nothing to be desired on the point of technique, either as regards sampling or the treatment of the samples thereafter. He thought the method was open to question on theoretical grounds, inasmuch as organic matter might use up some of the permanganate and thus lower the percentage of dissolved oxygen found. The Commission had introduced a check upon this possible source of error by making many blanks, but Professor Gill suggested that if pieces of solid, easily oxidizable putrescible matter were present in the sample in which the oxygen was determined and not in the blank, this would use up the permanganate and give rise to results which would be too low. This possibility seemed exceedingly remote, but to make certain, Professor Gill was requested to make parallel tests of the Commission's method with the familiar Winkler method and by eudiometric analyses in which the oxygen is boiled out of the water and analyzed as a gas.

In due course, Professor Gill reported that he had made a careful study of the method employed by the Commission with particular reference to the reliability of its procedure when compared with the Winkler method and by boiling out the oxygen, and from the results obtained, and from critical examinations of the method as practised by the Commission, he was convinced that the Commission's procedure gave the actual amount of dissolved oxygen present. Some of Professor Gill's results follow, samples of sea water from Boston and New York harbors being used:

Method	Cubic centimeters of dissolved oxygen per liter	
Metropolitan Sewerage Commission	5.84	6.00
Winkler	5.88	6.04
Gasometric	5.91	6.08
In a second series:		
Metropolitan Sewerage Commission	6.87	
Winkler	6.56	
Gasometric	6.70	
In a third series:		
Metropolitan Sewerage Commission	7.69	
Winkler	7.79	

Critical Examination of the Method by a Committee of Experts

For the prosecution of a suit brought in the United States Supreme Court by the State of New York against the State of New Jersey and the Passaic Valley Sewerage Commissioners to prevent the discharge of a large amount of sewage into New York harbor, a committee of experts was requested by New York to make an examination of the data obtained by the Metropolitan Sewerage Commission with respect to dissolved oxygen in the harbor waters and report upon the accuracy of the method. The committee included Messrs. Desmond Fitzgerald, Harrison P. Eddy and George A. Soper, Consulting Engineers, and the following practising chemists: Prof. Edward Ellery of Union College, Mr. Robert S. Weston of Boston, Prof. Earl B. Phelps of Boston and New York, and Prof. Floyd J. Metzger of Columbia University, New York. Messrs. Phelps, Ellery, Metzger and Weston undertook to compare, by means of independent researches, the results obtainable by the Commission's methods and by the Winkler and boiling-out procedures. After various conferences and considerable laboratory work, the committee reported that it had assured itself, through its own investigations, that the "method of determining dissolved oxygen, as adopted by the Metropolitan Sewerage Commission, is more reliable than the Winkler method and that the results obtained by the Metropolitan Sewerage Commission, so far as they are dependent upon the method used, are reliable, and that any further determinations which may be required should be made by this method."

Endorsement of the Commission's oxygen method is given by Prof. W. E. Adeney, who came to America to consult with the Commission and whose report is contained in this volume.

Reagents Used

The reagents used in the analytical method employed by the Commission for the determination of dissolved oxygen are as follows:

Standard Ferrous Sulphate. This is prepared by dissolving 144 grams of Kahlbaum's crystallized ferrous sulphate in water, adding 15 cubic centimeters of concentrated sulphuric acid and diluting the whole to 3 liters.

Standard Sodium Carbonate. Prepared by dissolving 100 grams of sodium carbonate crystals in 1 liter of water.*

Standard Sulphuric Acid. Prepared by mixing equal parts of concentrated sulphuric acid and water.

Standard Potassium Permanganate. Prepared by dissolving 25.4 grams of potassium permanganate in water and diluting to 4.5 liters. This reagent is to be standardized against especially prepared Mohr's salt.

Collection of Samples

Samples for examination are collected in the following manner: At the time of taking the sample the salinity of the water is determined by means of a salinometer devised for the Commission and the temperature of the water is carefully read.

Water is drawn up from the required depth through a ¾-inch wire-bound hose by a suction pump operated by steam in the boiler room of the boat. The actual lift is about 3 feet. A check valve at the lower end of the rubber hose in the water prevents an escape of water after the suction stops. The water passes through a glass reservoir having a capacity of 1 liter and thence to the pump. After running for a few minutes the pump is stopped. A separatory funnel which is to be used later for the analysis is filled from the rubber tube which leads by gravity from the glass reservoir. The stop-cock at the lower end of the separatory funnel is opened slightly in order to allow the funnel to fill rapidly from the reservoir.

For collecting samples at points where the rubber hose cannot be kept in a vertical position on account of tidal currents and for collecting deep samples, the apparatus shown in Fig. 84 is used. This consists of a casing made of heavy lead pipe 5 inches in diameter and 12 inches long, with a wooden bottom containing a 1-gallon glass bottle held in place by wire. The bottle has a rubber stopper perforated for 2 brass tubes, one of which extends 1 inch below the stopper and 2 inches above, while the other extends to the bottom of the bottle and is connected at the top by means of heavy rubber tubing with the separatory funnel. The separatory funnel is placed inside of a galvanized iron can 4 inches in diameter and 10 inches high, which is bolted to the rest of the apparatus. The top of the separatory funnel, which rests on a wooden support or ring fastened on the inside of the can, emerges through a small opening in the cover of the can. The funnel is held firmly in place by the wooden cover which works on hinges and is fastened down upon the can by a clamp. The rubber stopper of the funnel is perforated by two glass tubes, one extending to the bottom of the funnel and 1 inch above the stopper and the other to the bottom of the stopper and connected above with the gallon bottle by heavy rubber tubing.

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*The amount of sodium carbonate was erroneously stated as 30 grams per liter in the Commission's report of April 30, 1910. The length of time required for the Letts and Blake procedure was not so great as the report of 1910 indicated.

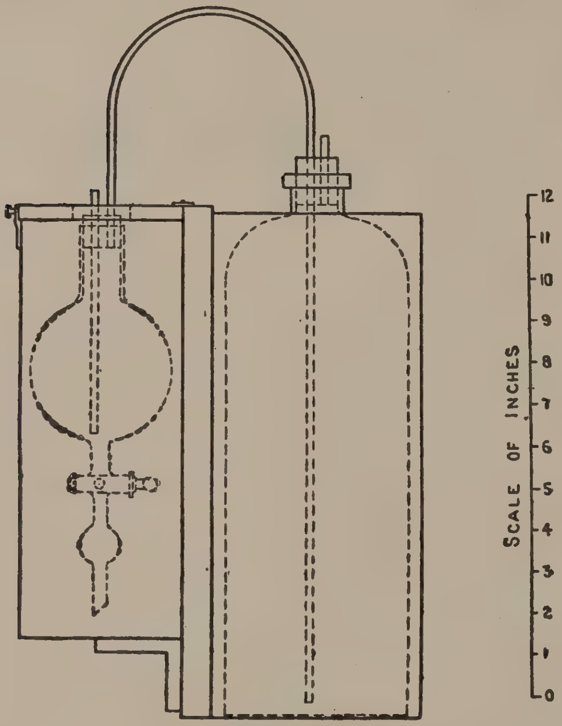

FIG. 84
Siphon Water Collector for Dissolved Oxygen

In collecting deep samples, the apparatus is rapidly lowered to the required depth by means of a one-half inch manila rope marked off in feet. The open end of the tube in the separatory funnel being lower than that of the large bottle, the water enters through the long tube of the separatory funnel and flows through the funnel into the gallon bottle, so that when the gallon bottle is full, as indicated by the cessation of air bubbles, the separatory funnel has been filled and emptied several times, the capacity of the funnels averaging about 350 cubic centimeters. Each funnel is accurately calibrated.

Method of Making Test

The separatory funnel, shown in Fig. 85, after being completely filled with water, is removed to a ring support and the contained water is immediately tested. Six cubic centimeters of ferrous sulphate and 4 cubic centimeters of sodium carbonate are added, both being delivered by a pipette near the bottom of the funnel. The stopper is then replaced and the contents are shaken. The dissolved oxygen in the presence of the alkali immediately acts upon a portion of the dissolved salt, precipitating it.

After five minutes the funnel is inverted and 10 c.c. of the standard sulphuric acid are introduced through the stem of the funnel, the stop-cock being opened for this purpose. After the acid has mixed thoroughly with the other contents, the funnel is allowed to stand until the mixture is nearly colorless (usually about 5 minutes). The contents of the funnel are then emptied into an Erlenmeyer flask and titrated with standard potassium permanganate.

A blank sample which has been collected in a similar manner to the first is now analyzed. In this case the separatory funnel is filled, as in the previous test, and 10 cubic centimeters of the standard sulphuric acid are added and the whole shaken. Then 6 cubic centimeters of standard ferrous sulphate are added and the funnel again shaken. The mixture is then run out into an Erlenmeyer flask and titrated with standard potassium permanganate. In this case the acid reaction prevents the dissolved oxygen from acting upon any of the ferrous salt.

By subtracting the result of titrating the first sample from the result of titrating the second, the amount of ferrous salt acted upon by the dissolved oxygen in the water is obtained.

Computing Results

Results are first stated in terms of cubic centimeters of dissolved oxygen per litre of water. Suppose 1 cubic centimeter of permanganate equals 1.009 cubic centimeters of oxygen at 0 degrees Centigrade and 760 millimeters pressure. The difference between the two titrations is multiplied by 1.009 and by 1,000 and divided by the number of cubic centimeters of water contained in the funnel.

The quantity of dissolved oxygen in the different samples collected was thus determined in terms of cubic centimeters per litre. The percentage of saturation of each sample was then calculated from a diagram prepared by the Commission for mixtures of sea and land waters based on a table contained in the Fifth Report of the Royal Commission on Sewage Disposal of Great Britain, Appendix VI, p. 58, which gives the saturation figures at different temperatures for sea water and distilled water.

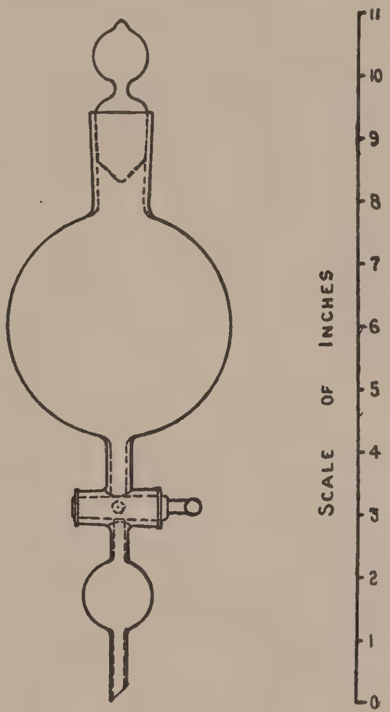

FIG. 85
Separatory Funnel Used in Dissolved Oxygen Analysis

The analyses were performed by Payn B. Parsons, A.M., M.D., the computations and diagrams by Charles A. Holden, C.E., and the plottings by Max L. Berrey, under the immediate direction of the President of the Commission.

INTRODUCTION TO TABLE XXI

The dissolved oxygen work done in the year 1909 was intended to cover the most important parts of the harbor, the scheme of sampling being varied between what were known as "courses" and "sections." When samples were taken on a course, the boat followed a channel from one part of the harbor to another. When samples were taken in a section, the boat moved across a channel and did not leave that part of the harbor. The object of sampling on a course was to examine the water at widely separated points at about the same time; when samples were collected from a section, the object was to find what changes occurred at closely connected points over a considerable period of time.

Location of Sample

In every case where samples were taken, the location of the point of collection was determined by reading angles to landmarks upon shore or by observing ranges or by estimating distances to nearby points on land. The location of the boat was later plotted by a draftsman from the notes of the collector, in many cases with the collector's assistance, so that the locations should be accurately recorded upon a map. The map used was a standard United States Coast and Geodetic Survey chart, scale 1/40,000. For the tabulations, the latitude and longitude of each point of collection was taken from this chart.

The distance from which the sample was collected below the surface was read by the collector from markings upon the rope by which the collecting apparatus was suspended. The tidal current and temperature were observed by the collector at the time of taking the sample. The percentage of land water in the mixture of land and sea water analyzed was determined by means of a special salinometer devised for the Commission's use, due allowance being made for temperature in making the percentage calculation.

Time of Making the Analysis

The oxygen was always determined in the sample at the time of collection. The percentage of saturation was calculated later and reported upon with the other data obtained on special printed forms. The force and direction of the wind were noted by the analyst at the time of collection, and the time of low and high water was that officially registered by an automatic tide gage maintained by the Engineering Corps of the United States Army.

TABLE XXI

VOLUME AND PERCENTAGE OF SATURATION OF DISSOLVED OXYGEN IN THE WATER IN THE YEAR 1909

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61	Kill van Kull	Sept. 30, 1909	333
62	East river	Oct. 1, 1909	334
63	Long Island Sound	Oct. 1, 1909	334
64	East river and Harlem river	Oct. 1, 1909	334
65	East river	Oct. 2, 1909	335
66	Hudson river	Oct. 5, 1909	336

TABLE XXI

Volume and Percentage of Saturation of Dissolved Oxygen in the Water in the Year 1909

1—KILL VAN KULL, CROSS-SECTION AND COURSE. JUNE 1, 1909

Low water occurred at Governor's Island at 11.52 A. M. The wind was southeast with a velocity of 5 miles per hour

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
35	11.15	20 feet off Columbia Oil Co. pier, Bayonne	40 39 02	74 05 26	1	Ebb	18.0	32	5.04	85
36	11.20	20 feet off Columbia Oil Co. pier, Bayonne	40 39 02	74 05 26	20	Ebb	18.0	32	5.16	87
37	11.45	Midstream, off Jersey street, New Brighton, S. I.	40 38 57	74 05 25	1	Ebb	18.0	32	5.34	90
38	11.55	Midstream, off Jersey street, New Brighton, S. I.	40 38 57	74 05 25	40	Ebb	18.0	32	5.47	93
	P. M.									
39	12.20	20 feet off pier at foot of Jersey street, New Brighton, S. I.	40 38 51	74 05 24	1	Ebb	18.0	32	4.75	80
40	12.30	20 feet off pier at foot of Jersey street, New Brighton, S. I.	40 38 51	74 05 24	10	Ebb	18.0	32	5.16	87
41	1.40	Midstream, off Port Richmond ferry, S. I.	40 38 35	74 07 52	1	Flood	18.0	32	5.34	91
42	2.00	Midstream, off Port Richmond ferry, S. I.	40 38 35	74 07 52	40	Flood	18.0	32	5.16	87
43	2.20	Midstream, off Sailors' Snug Harbor, S. I.	40 38 50	74 06 07	1	Flood	18.0	32	5.64	96
44	2.30	Midstream, off Sailors' Snug Harbor, S. I.	40 38 50	74 06 07	40	Flood	17.5	32	5.47	93
45	2.50	20 feet off Columbia Oil Co. pier, Bayonne	40 39 02	74 05 26	1	Flood	17.5	32	5.64	96
46	3.00	20 feet off Columbia Oil Co. pier, Bayonne	40 39 02	74 05 26	20	Flood	17.5	32	5.77	98
47	3.10	Midstream, off Jersey street, New Brighton	40 38 57	74 05 25	1	Flood	17.5	32	5.64	96
48	3.20	Midstream, off Jersey street, New Brighton	40 38 57	74 05 25	40	Flood	17.5	32	5.77	98
49	3.40	20 feet off pier at foot of Jersey street, New Brighton, S. I.	40 38 51	74 05 24	1	Flood	17.0	32	5.34	90
50	4.00	20 feet off pier at foot of Jersey street, New Brighton, S. I.	40 38 51	74 05 24	10	Flood	17.0	32	5.47	93

Note.—Samples 1–34 covered preliminary studies of the method.

2—HARLEM RIVER, COURSE. JUNE 2, 1909

Low water occurred at Governor's Island at 12.47 P. M. The wind was east with a velocity of 5 miles per hour.

	A. M.									
51	11.40	200 feet east of Spuyten Duyvil drawbridge	40 52 41	73 55 29	1	Ebb	18.0	36	4.45	74
52	11.50	200 feet east of Spuyten Duyvil drawbridge	40 52 41	73 55 29	16	Ebb	18.0	36	4.56	76
	P. M.									
53	12.30	At 155th street Bridge, midstream	40 49 40	73 56 03	1	Ebb	18.0	36	4.45	74
54	12.40	At 155th street Bridge, midstream	40 49 40	73 56 03	20	Ebb	18.0	36	4.56	76

Note.—In the Harlem river the ebb current flows from the East river toward the Hudson River and the flood current from the Hudson river toward the East river.

TABLE XXI—Continued

3—HARLEM RIVER, CROSS-SECTION AT THIRD AVENUE. JUNE 2, 1909

Low water occurred at Governor's Island at 12.47 P. M. The wind was east with a velocity of 5 miles per hour.

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
55	1.20	At Third Avenue Bridge, 20 feet from west shore	40 48 25	73 56 00	1	Ebb	18.0	36	3.56	59
56	1.25	At Third Avenue Bridge, 20 feet from west shore	40 48 25	73 56 00	20	Ebb	18.0	36	3.65	61
57	1.35	At Third Avenue Bridge, midstream	40 48 25	73 55 57	1	Ebb	18.0	36	3.56	59
58	1.40	At Third Avenue Bridge, midstream	40 48 25	73 55 57	20	Ebb	18.0	36	3.34	56
59	1.50	At Third Avenue Bridge, 20 feet from east shore	40 48 25	73 55 55	1	Ebb	18.0	36	3.26	54
60	1.55	At Third Avenue Bridge, 20 feet from east shore	40 48 25	73 55 55	20	Ebb	18.0	36	3.34	56
61	4.05	At Third Avenue Bridge, 20 feet from west shore	40 48 25	73 56 00	1	Flood	18.0	36	3.86	64
62	4.10	At Third Avenue Bridge, 20 feet from west shore	40 48 25	73 56 00	20	Flood	18.0	36	3.95	66
63	4.25	At Third Avenue Bridge, midstream	40 48 25	73 55 57	1	Flood	18.0	36	3.86	64
64	4.30	At Third Avenue Bridge, midstream	40 48 25	73 55 57	20	Flood	18.0	36	3.95	66
65	4.45	At Third Avenue Bridge, 20 feet from east shore	40 48 25	73 55 55	1	Flood	18.0	36	3.56	59
66	4.50	At Third Avenue Bridge, 20 feet from east shore	40 48 25	73 55 55	20	Flood	18.0	36	3.34	56

4—HUDSON RIVER, CROSS-SECTION AT RIVERDALE. JUNE 16, 1909

Low water occurred at Governor's Island at 1.09 P. M. The wind was northwest with a velocity of 10 miles per hour.

	P. M.									
67	1.10	Opposite Riverdale, N. Y., 250 feet off New Jersey shore	40 54 15	73 55 48	1	Ebb	20.0	72	6.23	100
68	1.15	Opposite Riverdale, N. Y., 250 feet off New Jersey shore	40 54 15	73 55 48	15	Ebb	20.0	72	6.08	98
69	1.30	Opposite Riverdale, N. Y., midstream	40 54 10	73 55 25	1	Ebb	20.0	72	6.23	100
70	1.35	Opposite Riverdale, N. Y., midstream	40 54 10	73 55 25	30	Ebb	20.0	72	6.08	98
71	1.55	Opposite Riverdale, N. Y., 50 feet off Riverdale pier	40 54 05	73 54 55	1	Ebb	20.0	72	5.93	96
72	2.00	Opposite Riverdale, N. Y., 50 feet off Riverdale pier	40 54 05	73 54 55	10	Ebb	20.0	72	5.77	93
73	3.30	Opposite Riverdale, N. Y., 250 feet off New Jersey shore	40 54 15	73 55 48	1	Flood	20.0	72	5.65	91
74	3.40	Opposite Riverdale, N. Y., 250 feet off New Jersey shore	40 54 15	73 55 48	15	Flood	20.0	72	5.77	93
75	4.10	Opposite Riverdale, N. Y., midstream	40 54 10	73 55 25	1	Flood	20.0	72	5.93	96
76	4.15	Opposite Riverdale, N. Y., midstream	40 54 10	73 55 25	30	Flood	19.5	72	5.77	93
77	4.35	Opposite Riverdale, N. Y., 50 feet off Riverdale pier	40 54 05	73 54 55	1	Flood	20.0	72	5.34	86
78	4.40	Opposite Riverdale, N. Y., 50 feet off Riverdale pier	40 54 05	73 54 55	10	Flood	20.0	72	5.47	88

5—NEWARK BAY, CROSS-SECTION, AND PASSAIC RIVER. JUNE 17, 1909

Low water occurred at Governor's Island at 1.52 P. M. The wind was southeast with a velocity of 30 miles per hour.

	P. M.									
79	12.10	Newark bay, at C. R.R. of N. J. bridge, 200 feet from east shore	40 39 17	74 08 27	1	Ebb	21.0	32	4.15	74
80	12.15	Newark bay, at C. R.R. of N. J. bridge, 200 feet from east shore	40 39 17	74 08 27	10	Ebb	21.0	32	4.21	75

TABLE XXI—Continued

5—NEWARK BAY, CROSS-SECTION, AND PASSAIC RIVER. JUNE 17, 1909—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ' "	° ' "						
81	12.25	Newark bay, at C. R.R. of N. J. bridge, near draw	40 39 17	74 08 46	1	Ebb	21.0	32	4.45	80
82	12.30	Newark bay, at C. R.R. of N. J. bridge, near draw	40 39 17	74 08 46	20	Ebb	21.0	32	4.55	81
83	12.45	Newark bay, at C. R.R. of N. J. bridge, ¾ way across from east shore	40 39 17	74 09 40	1	Ebb	21.0	32	4.60	82
84	12.50	Newark bay, at C. R.R. of N. J. bridge, ¾ way across from east shore	40 39 17	74 09 40	10	Ebb	21.0	32	4.32	77
85	1.25	Passaic river, near mouth of C. R.R. of N. J. bridge	40 43 21	74 07 18	1	Ebb	21.5	52	1.82	31
86	1.30	Passaic river, near mouth, at C. R.R. of N. J. bridge	40 43 21	74 07 18	10	Ebb	21.5	52	1.79	31
87	2.00	Passaic river, at foot of N. J. R.R. avenue, Newark	40 44 49	74 09 56	1	Ebb	22.0	52	0.63	11
88	2.10	Passaic river, at foot of N. J. R.R. avenue, Newark	40 44 49	74 09 56	10	Ebb	22.0	52	0.59	10
89	3.00	Passaic river, at foot of N. J. R.R. avenue, Newark	40 44 49	74 09 56	1	Flood	22.0	52	0.70	12
90	3.02	Passaic river, at foot of N. J. R.R. avenue, Newark	40 44 49	74 09 56	10	Flood	22.0	52	0.99	17
91	3.40	Passaic river, near mouth, at C. R.R. of N. J. bridge	40 43 21	74 07 18	1	Flood	21.0	52	3.57	62
92	3.45	Passaic river, near mouth, at C. R.R. of N. J. bridge	40 43 21	74 07 18	10	Flood	21.0	52	3.65	63
93	4.40	Newark bay, at C. R.R. of N. J. bridge, 200 feet from east shore	40 39 17	74 08 27	1	Flood	20.0	28	4.76	83
94	4.45	Newark bay, at C. R.R. of N. J. bridge, 200 feet from east shore	40 39 17	74 08 27	10	Flood	20.0	28	4.86	85
95	4.55	Newark bay, at C. R.R. of N. J. bridge, near draw	40 39 17	74 08 46	1	Flood	20.0	28	5.05	89
96	5.00	Newark bay, at C. R.R. of N. J. bridge, near draw	40 39 17	74 08 46	20	Flood	20.0	28	5.17	91
97	5.10	Newark bay, at C. R.R. of N. J. bridge, ¾ way across from east shore	40 39 17	74 09 40	1	Flood	20.0	28	5.05	89
98	5.15	Newark bay, at C. R.R. of N. J. bridge, ¾ way across from east shore	40 39 17	74 09 40	10	Flood	20.0	28	4.86	85

6—HARLEM RIVER, CROSS-SECTION AT EAST 118TH STREET. JUNE 21, 1909

Low water occurred at Governor's Island at 4.37 P. M. The wind was west with a velocity of 5 miles per hour.

	A. M.									
99	10.30	Opposite East 118th street, 20 feet off Randall's Island	40 47 40	73 55 40	1	Flood	19.0	36	2.64	45
100	10.35	Opposite East 118th street, 20 feet off Randall's Island	40 47 40	73 55 40	20	Flood	19.0	36	3.18	55
101	10.45	Opposite East 118th street, midstream	40 47 41	73 55 44	1	Flood	19.0	36	3.24	56
102	10.50	Opposite East 118th street, midstream	40 47 41	73 55 44	20	Flood	19.0	36	2.54	44
103	11.00	20 feet off dock, foot of East 118th street	40 47 43	73 55 48	1	Flood	19.0	36	2.25	39
104	11.05	20 feet off dock, foot of East 118th street	40 47 43	73 55 48	20	Flood	19.0	36	2.95	51
	P. M.									
105	3.20	Opposite East 118th street, 20 feet off Randall's Island	40 47 40	73 55 40	1	Ebb	19.0	36	3.50	60
106	3.25	Opposite East 118th street, 20 feet off Randall's Island	40 47 40	73 55 40	20	Ebb	19.0	36	4.10	71
107	3.30	Opposite East 118th street, midstream	40 47 41	73 55 44	1	Ebb	19.0	36	3.45	60
108	3.35	Opposite East 118th street, midstream	40 47 41	73 55 44	20	Ebb	19.0	36	3.11	54
109	3.40	20 feet off dock, foot of East 118th street	40 47 43	73 55 48	1	Ebb	19.0	36	3.35	58
110	3.45	20 feet off dock, foot of East 118th street	40 47 43	73 55 48	20	Ebb	19.0	36	3.70	64

TABLE XXI—Continued

7—EAST RIVER, CROSS-SECTION BETWEEN LAWRENCE POINT AND STONY POINT. JUNE 21, 1909

Low water occurred at Governor's Island at 4.37 P. M. The wind was west with a velocity of 5 miles per hour.

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
111	11.55	20 feet off dock at Lawrence Point. . .	40 47 25	73 54 35	1	Flood	19.0	32	3.30	57
112	12.00	20 feet off dock at Lawrence Point. . .	40 47 25	73 54 35	20	Flood	19.0	32	3.20	55
	P. M.									
113	12.10	Midstream, off Lawrence Point.	40 47 45	73 54 31	1	Flood	19.0	32	3.82	66
114	12.15	Midstream, off Lawrence Point.	40 47 45	73 54 31	70	Flood	19.0	32	3.62	62
115	12.25	20 feet off ferry slip, Stony Point.	40 47 57	73 54 31	1	Flood	19.0	32	3.58	62
116	12.30	20 feet off ferry slip, Stony Point.	40 47 57	73 54 31	40	Flood	19.0	32	4.12	71
117	4.05	20 feet off dock at Lawrence Point. . . .	40 47 25	73 54 35	1	Ebb	18.0	32	4.42	76
118	4.10	20 feet off dock at Lawrence Point. . . .	40 47 25	73 54 35	20	Ebb	18.0	32	4.34	75
119	4.15	Midstream, off Lawrence Point.	40 47 45	73 54 31	1	Ebb	18.0	32	4.92	85
120	4.20	Midstream, off Lawrence Point.	40 47 45	73 54 31	70	Ebb	18.0	32	4.72	81
121	4.25	20 feet off ferry slip, Stony Point.	40 47 57	73 54 31	1	Ebb	18.0	32	4.04	70
122	4.30	20 feet off ferry slip, Stony Point.	40 47 57	73 54 31	40	Ebb	18.0	32	4.12	71

8—EAST RIVER, CROSS-SECTION AT THROG'S NECK. JUNE 23, 1909

High water occurred at Governor's Island at 12.20 P. M. The wind was south with a velocity of 5 miles per hour.

	A. M.									
123	11.00	50 feet off west dock, Throg's Neck. . .	40 48 19	73 47 45	1	Flood	18.5	28	5.16	88
124	11.05	50 feet off west dock, Throg's Neck. . .	40 48 19	73 47 45	30	Flood	18.5	28	5.05	86
125	11.20	¼ way across river from Throg's Neck	40 48 12	73 47 48	1	Flood	18.5	28	5.47	93
126	11.25	¼ way across river from Throg's Neck	40 48 12	73 47 48	40	Flood	18.0	28	5.34	91
127	11.40	½ way across river from Throg's Neck	40 48 04	73 47 52	1	Flood	18.5	28	5.77	98
128	11.45	½ way across river from Throg's Neck	40 48 04	73 47 52	70	Flood	18.0	28	5.65	96
129	12.00	¾ way across river from Throg's Neck	40 47 51	73 47 56	1	Flood	18.5	28	5.77	98
	P. M.									
130	12.05	¾ way across river from Throg's Neck	40 47 51	73 47 56	40	Flood	18.0	28	5.65	96
131	12.20	50 feet off dock at Beechhurst, L. I., west of Willet's Point.	40 47 48	73 48 00	1	Flood	18.5	28	5.16	88
132	12.25	50 feet off dock at Beechhurst, L. I., west of Willet's Point.	40 47 48	73 48 00	20	Flood	18.0	28	5.34	91
133	3.05	50 feet off west dock, Throg's Neck. . .	40 48 19	73 47 45	1	Ebb	18.5	28	6.08	103
134	3.10	50 feet off west dock, Throg's Neck. . .	40 48 19	73 47 45	30	Ebb	18.0	28	5.93	101
135	3.25	¼ way across river from Throg's Neck	40 48 12	73 47 48	1	Ebb	18.5	28	6.08	103
136	3.30	¼ way across river from Throg's Neck	40 48 12	73 47 48	40	Ebb	18.0	28	5.93	101
137	3.45	½ way across river from Throg's Neck	40 48 04	73 47 52	1	Ebb	18.5	28	6.38	108
138	3.50	½ way across river from Throg's Neck	40 48 04	73 47 52	70	Ebb	18.0	28	6.23	106
139	4.05	¾ way across river from Throg's Neck	40 47 51	73 47 56	1	Ebb	18.5	28	5.93	101
140	4.10	¾ way across river from Throg's Neck	40 47 51	73 47 56	40	Ebb	18.0	28	5.65	96
141	4.25	50 feet off dock at Beechhurst, L. I., west of Willet's Point.	40 47 48	73 48 00	1	Ebb	18.5	28	6.08	103
142	4.30	50 feet off dock at Beechhurst, L. I., west of Willet's Point.	40 47 48	73 48 00	20	Ebb	18.5	28	5.93	101

9—THE NARROWS, CROSS-SECTION BETWEEN FT. WADSWORTH AND FT. LAFAYETTE. JUNE 24, 1909.

High water occurred at Governor's Island at 1.23 P. M. The wind was west, with a velocity of 5 miles per hour.

	A. M.									
143	10.00	50 feet off Fort Wadsworth.	40 36 21	74 03 13	1	Flood	19.0	20	5.34	95
144	10.05	50 feet off Fort Wadsworth.	40 36 21	74 03 13	40	Flood	18.0	20	5.25	94
145	10.20	¼ way across Narrows from Fort Wadsworth.	40 36 23	74 03 02	1	Flood	19.0	20	5.47	98
146	10.25	¼ way across Narrows from Fort Wadsworth.	40 36 23	74 03 02	60	Flood	18.0	20	5.34	95

TABLE XXI—Continued

9—THE NARROWS. JUNE 24, 1909—Continued

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
147	10.40	½ way across Narrows	40 36 25	74 02 48	1	Flood	19.0	20	5.82	104
148	10.45	½ way across Narrows	40 36 25	74 02 48	60	Flood	18.0	20	5.49	95
149	11.00	¾ way across Narrows from Fort Wadsworth	40 36 27	74 02 34	1	Flood	19.0	20	5.77	103
150	11.05	¾ way across Narrows from Fort Wadsworth	40 36 27	74 02 34	60	Flood	18.0	20	5.54	96
151	11.20	50 feet off Fort Lafayette, east shore	40 36 29	74 02 23	1	Flood	19.0	20	5.64	101
152	11.25	50 feet off Fort Lafayette, east shore	40 36 29	74 02 23	10	Flood	19.0	20	5.77	103
	P. M.									
153	3.20	50 feet off Fort Wadsworth	40 36 21	74 03 13	1	Ebb	20.5	28	4.72	84
154	3.25	50 feet off Fort Wadsworth	40 36 21	74 03 13	40	Ebb	18.0	28	4.15	70
155	3.40	¼ way across Narrows from Fort Wadsworth	40 36 23	74 03 02	1	Ebb	20.5	28	4.60	82
156	3.45	¼ way across Narrows from Fort Wadsworth	40 36 23	74 03 02	60	Ebb	18.0	28	3.64	62
157	4.00	½ way across Narrows	40 36 25	74 02 48	1	Ebb	20.5	28	4.96	89
158	4.05	½ way across Narrows	40 36 25	74 02 48	60	Ebb	18.0	28	3.95	67
159	4.20	¾ way across Narrows from Fort Wadsworth	40 36 27	74 02 34	1	Ebb	20.5	28	5.11	91
160	4.25	¾ way across Narrows from Fort Wadsworth	40 36 27	74 02 34	60	Ebb	18.0	28	4.15	70
161	4.40	50 feet off Fort Lafayette, east shore	40 36 29	74 02 23	1	Ebb	20.5	28	4.60	82
162	4.45	50 feet off Fort Lafayette, east shore	40 36 29	74 02 23	10	Ebb	20.0	28	4.45	80

10—EAST RIVER, CROSS SECTION BETWEEN PIER 10, MANHATTAN, AND PIER 10, BROOKLYN. JUNE 25, 1909

High water occurred at Governor's Island at 2.03 P. M. The wind was west with a velocity of 8 miles per hour.

	A. M.									
163	9.45	50 feet off Pier 10, Manhattan	40 42 09	74 00 22	1	Flood	20.5	28	4.08	73
164	9.48	50 feet off Pier 10, Manhattan	40 42 09	74 00 22	30	Flood	19.5	28	4.25	75
165	10.00	¼ way across East river from Pier 10, Manhattan	40 42 07	74 00 17	1	Flood	20.5	28	4.45	80
166	10.05	¼ way across East river from Pier 10, Manhattan	40 42 07	74 00 17	40	Flood	19.0	28	4.08	70
167	10.20	½ way across East river	40 42 03	74 00 11	1	Flood	20.5	28	4.37	78
168	10.25	½ way across East river	40 42 03	74 00 11	40	Flood	19.0	28	3.95	68
169	10.40	¾ way across East river from Pier 10, Manhattan	40 42 00	74 00 05	1	Flood	20.5	28	4.15	74
170	10.45	¾ way across East river from Pier 10, Manhattan	40 42 00	74 00 05	40	Flood	19.0	28	3.79	65
171	11.00	50 feet off Pier 10, Brooklyn	40 41 57	74 00 00	1	Flood	20.5	28	3.79	68
172	11.05	50 feet off Pier 10, Brooklyn	40 41 57	74 00 00	40	Flood	19.0	28	3.65	63
	P. M.									
173	2.55	50 feet off Pier 10, Manhattan	40 42 09	74 00 22	1	Ebb	21.0	28	3.26	59
174	3.00	50 feet off Pier 10, Manhattan	40 42 09	74 00 22	30	Ebb	20.0	28	2.43	43
175	3.15	¼ way across East river from Pier 10, Manhattan	40 42 07	74 00 17	1	Ebb	21.0	28	3.50	64
176	3.20	¼ way across East river from Pier 10, Manhattan	40 42 07	74 00 17	40	Ebb	20.0	28	2.97	52
177	3.35	½ way across East river	40 42 03	74 00 11	1	Ebb	21.0	28	3.86	69
178	3.40	½ way across East river	40 42 03	74 00 11	40	Ebb	20.0	28	2.97	52
179	3.55	¾ way across East river from Pier 10, Manhattan	40 42 00	74 00 05	1	Ebb	21.0	28	3.83	70
180	4.00	¾ way across East river from Pier 10, Manhattan	40 42 00	74 00 05	40	Ebb	20.0	28	3.11	55
181	4.15	50 feet off Pier 10, Brooklyn	40 41 57	74 00 00	1	Ebb	21.0	28	3.56	65
182	4.20	50 feet off Pier 10, Brooklyn	40 41 57	74 00 00	40	Ebb	20.0	28	2.67	47

TABLE XXI—Continued

11—NEWTOWN CREEK. JUNE 25, 1909

High water occurred at Governor's Island at 2.03 P. M.

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
183	11.35	At Vernon Avenue Bridge............	40 44 21	73 57 20	1	Flood	25.5	32	0.00	0
184	11.45	At Greenpoint Avenue Bridge........	40 44 00	73 56 30	1	Flood	25.5	32	0.00	0
185	11.55	At Meaker Avenue Bridge...........	40 43 40	73 55 00	1	Flood	25.5	32	0.00	0

12—WALLABOUT CANAL. JUNE 25, 1909

High water occurred at Governor's Island at 2.03 P. M.

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
	P. M.									
186	1.20	In Canal, near Wallabout Market....	40 42 12	73 58 08	1	Flood	25.0	32	0.30	6

13—GOWANUS BAY AND CANAL. JUNE 26, 1909

High water occurred at Governor's Island at 2.38 P. M.

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
	A. M.									
187	10.05	Gowanus Canal at 9th Street Bridge..	40 40 25	73 59 50	1	Ebb	25.5	28	0.00	0
188	10.35	Gowanus Canal, at Hamilton Avenue Bridge...........................	40 40 17	73 59 56	1	Ebb	25.5	28	0.00	0
189	10.55	Gowanus bay at entrance to canal....	40 39 55	74 00 25	1	Ebb	24.0	28	1.06	20
190	11.15	Gowanus bay at outer end...........	40 39 40	74 01 00	1	Ebb	21.5	28	2.04	37
191	11.35	By spar buoy off Gowanus bay.......	40 39 45	74 01 20	1	Ebb	21.0	28	2.26	41

14—WALLABOUT BAY. JUNE 28, 1909

High water occurred at Governor's Island at 4.17 P. M. The wind was northwest with a velocity of 10 miles per hour.

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
	P. M.									
192	1.05	Near sewer outlet, foot Division avenue, Wallabout bay....................	40 42 20	73 58 15	1	Flood	26.0	70	0.00	0
193	1.20	Near sewer outlet, foot Division avenue, Wallabout bay....................	40 42 20	73 58 15	10	Flood	21.0	40	2.08	37
194	1.45	200 feet off foot of 11th street, Wallabout bay.........................	40 42 25	73 58 15	1	Flood	21.0	40	0.61	11
195	1.55	200 feet off foot of 11th street, Wallabout bay.........................	40 42 25	73 58 15	10	Flood	20.5	40	2.43	43
196	2.20	Outer end of Wallabout bay, junction with East river....................	40 42 30	73 58 15	1	Flood	20.5	40	1.17	21
197	2.40	Outer end of Wallabout bay, junction with East river....................	40 42 30	73 58 15	10	Flood	19.5	32	3.64	64
198	3.20	East river under Williamsburg Bridge, 100 feet from Brooklyn shore.......	40 42 45	73 58 10	1	Flood	19.5	32	3.56	63
199	3.35	East river, under Williamsburg Bridge, 100 feet from Brooklyn shore.......	40 42 45	73 58 10	10	Flood	19.0	32	3.95	68

15—ROCKAWAY INLET, CROSS-SECTION. JUNE 29, 1909

High water occurred at Governor's Island at 5.13 P. M. The wind was northwest with a velocity of 5 miles per hour

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
	P. M.									
200	12.50	50 feet off dock at Rockaway Point...	40 34 05	73 53 50	1	Ebb	20.5	16	5.31	97
201	1.10	50 feet off dock at Rockaway Point...	40 34 05	73 53 50	20	Ebb	20.5	16	5.31	97
202	1.20	½ way across inlet..................	40 34 15	73 53 55	1	Ebb	20.5	16	5.04	92
203	1.30	½ way across inlet..................	40 34 15	73 53 55	40	Ebb	20.5	16	5.17	94
204	1.40	By gas buoy 2 at west side of inlet....	40 34 20	73 54 05	1	Ebb	20.5	16	4.81	88
205	1.50	By gas buoy 2 at west side of inlet....	40 34 20	73 54 05	10	Ebb	20.5	16	4.93	90

TABLE XXI—Continued

16—JAMAICA BAY. JUNE 29, 1909

High water occurred at Governor's Island at 5.13 P. M. The wind was northwest with a velocity of 5 miles per hour.

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
206	2.15	100 feet off dock at Belle Harbor	40 34 55	73 51 05	1	Flood	21.5	16	5.04	93
207	2.30	100 feet off dock at Belle Harbor	40 34 55	73 51 05	10	Flood	21.5	16	5.17	96
208	3.05	100 feet off dock at Seaside, Rockaway Beach	40 35 10	73 49 35	1	Flood	22.5	20	4.15	78
209	3.15	100 feet off dock at Seaside, Rockaway Beach	40 35 10	73 49 35	10	Flood	22.5	20	4.56	86
210	3.35	At drawbridge, near Hammel's station	40 35 45	73 48 50	1	Flood	23.0	20	4.15	80
211	3.45	At drawbridge, near Hammel's station	40 35 45	73 48 50	10	Flood	22.5	20	4.25	80
212	5.00	Foot of Bayswater avenue, Far Rockaway	40 36 30	73 46 15	1	Flood	23.0	24	4.15	80
213	5.20	By bridge at head of Norton's creek	40 36 00	73 46 10	1	Flood	27.0	28	3.86	77

17—JAMAICA BAY. JUNE 30, 1909

Low water occurred at Governor's Island at 11.57 A. M. The wind was northwest with a velocity of 5 miles per hour.

214	A. M. 7.30	At bridge, head of Norton's creek	40 36 00	73 46 10	1	Ebb	27.0	28	3.26	65
215	7.50	Foot Bayswater avenue, Far Rockaway	40 36 15	73 46 10	1	Ebb	25.0	28	3.86	74
216	8.30	In creek, near Arverne station	40 35 40	73 47 25	1	Ebb	27.0	28	0.00	0
217	9.50	In same creek, 1000 feet from shore	40 36 05	73 47 20	1	Ebb	25.0	28	3.26	63
218	10.20	Cross channel off Arverne, parallel to Beach channel	40 35 50	73 48 25	1	Ebb	25.0	28	3.26	63
219	P. M. 1.10	100 feet off foot of Bannister avenue, Arverne, near sewer outlet	40 35 45	73 48 15	1	Flood	26.0	28	0.29	6
220	1.40	Foot of Pleasant street, Arverne	40 35 35	73 48 25	1	Flood	27.0	28	1.48	30
221	2.20	Foot of Park avenue, Arverne	40 35 30	73 48 20	1	Flood	27.0	28	1.48	30
222	3.05	Front yard of house, near foot of Pleasant avenue	40 35 35	73 48 10	1	Flood	27.0	28	1.19	24

18—JAMAICA BAY. JULY 1, 1909

Low water occurred at Governor's Island at 12.37 P. M. The wind was southwest with a velocity of 5 miles per hour.

223	A. M. 8.25	Fresh creek, at mouth	40 38 30	73 52 55	1	Ebb	25.0	28	2.97	57
224	9.10	Fresh creek, ½ way up	40 38 50	73 53 20	1	Ebb	25.0	28	2.97	57
225	9.50	Fresh creek, 200 yards below railroad crossing	40 39 15	73 53 45	1	Ebb	25.5	28	2.67	51
226	10.45	Second creek, near sewer outlet	40 39 05	73 53 00	1	Ebb	26.0	28	0.00	0
227	11.05	Second Creek, at mouth	40 38 55	73 52 40	1	Ebb	25.5	28	0.59	12
228	11.35	Jamaica bay, 500 feet off mouth Second creek	40 38 35	73 52 25	1	Ebb	25.5	28	1.19	23
229	12.00	Jamaica bay, 500 feet off mouth of Fresh creek	40 38 25	73 52 30	1	Ebb	25.5	28	2.08	41
230	P. M. 12.50	Jamaica bay, 500 feet off Sand Bay shore	40 37 50	73 53 05	1	Flood	25.0	20	2.67	53
231	1.20	Creek running back through Canarsie	40 38 15	73 54 00	1	Flood	25.0	20	3.56	71
232	1.45	Jamaica bay, 100 feet off main landing, Canarsie	40 37 40	73 53 15	1	Flood	24.0	20	4.15	80
233	2.05	Jamaica bay, 200 feet off bath pool, Bergen Beach	40 37 00	73 53 45	1	Flood	24.0	20	4.75	91

TABLE XXI—Continued

19—ROCKAWAY INLET, CROSS-SECTION. JULY 1, 1909

High water occurred at Governor's Island at 6.47 P. M. The wind was southwest with a velocity of 10 miles per hour.

Sample No.	Hour P. M.	Location of Samples: Approximate	Location of Samples: Latitude	Location of Samples: Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen: C. C. per litre	Oxygen: Per cent. saturation
			° ′ ″	° ′ ″						
234	2.45	50 feet off dock at Rockaway Point...	40 34 05	73 53 50	1	Flood	19.0	8	5.93	108
235	2.50	50 feet off dock at Rockaway Point...	40 34 05	73 53 50	20	Flood	19.0	8	6.08	111
236	3.05	½ way across inlet..................	40 34 15	73 53 55	1	Flood	19.0	8	6.23	113
237	3.10	½ way across inlet..................	40 34 15	73 53 55	40	Flood	19.0	8	6.18	112
238	3.25	By gas buoy 2 at west side of inlet....	40 34 20	73 54 05	1	Flood	19.0	8	6.18	112
239	3.30	By gas buoy 2 at west side of inlet....	40 34 20	73 54 05	10	Flood	19.0	8	6.23	113

20—HARLEM RIVER AT 118TH STREET. JULY 2, 1909

Low water occurred at Governor's Island at 1.23 P. M. The wind was west with a velocity of 5 miles per hour.

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
240	A.M. 10.30	Harlem river, midstream off East 118th street............................	40 47 41	73 55 44	1	Ebb	20.0	28	2.22	39
241	10.40	Harlem river, midstream off East 118th street............................	40 47 41	73 55 44	20	Ebb	20.0	28	2.37	42

21—EAST RIVER COURSE FROM HELL GATE TO BROOKLYN BRIDGE. JULY 2, 1909.

Low water occurred at Governor's Island at 1.23 P. M. The wind was west with a velocity of 5 miles per hour

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
242	A. M. 11.00	East river, midstream, opposite East 92d street........................	40 46 50	73 56 25	1	Ebb	19.5	28	2.91	51
243	11.10	East river, midstream, opposite East 92d street........................	40 46 50	73 56 25	30	Ebb	19.0	28	3.04	52
244	11.20	East river, midstream, opposite East 92d street........................	40 46 50	73 56 25	60	Ebb	18.0	28	3.50	59
245	11.40	East river, off East 80th street.......	40 46 10	73 56 50	1	Ebb	19.5	28	2.91	51
246	11.50	East river, off East 80th street.......	40 46 10	73 56 50	60	Ebb	18.0	28	3.34	57
247	P. M. 12.10	East river, at Queensboro Bridge, west channel, midstream...............	40 45 25	73 57 30	1	Ebb	19.5	28	3.26	57
248	12.20	East river, at Queensboro Bridge, west channel, midstream...............	40 45 25	73 57 30	35	Ebb	19.0	28	3.34	58
249	12.30	East river, at Queensboro Bridge, west channel, midstream...............	40 45 25	73 57 30	70	Ebb	18.0	28	3.50	59
250	12.50	East river, midstream, opposite East 42d street........................	40 44 50	73 57 55	1	Ebb	19.5	28	3.26	57
251	1.05	East river, midstream, opposite East 42d street........................	50 44 50	73 57 55	40	Ebb	18.5	28	3.50	59
252	1.25	East river, midstream, opposite East 23d street........................	40 44 00	73 58 05	1	Ebb	19.5	28	3.20	56
253	1.35	East river, midstream, opposite East 23d street........................	40 44 00	73 58 05	20	Ebb	19.0	28	3.04	52
254	1.45	East river, midstream, opposite East 23d street........................	40 44 00	73 58 05	40	Ebb	18.5	28	3.26	55
255	2.05	East river, midstream, at Williamsburg Bridge..........................	40 42 49	73 58 21	1	Ebb	19.0	28	3.26	57
256	2.15	East river, midstream, at Williamsburg Bridge..........................	40 42 49	73 58 21	40	Ebb	18.0	28	3.34	57
257	2.50	East river, midstream, at Brooklyn Bridge..........................	40 42 20	73 59 48	1	Slack	19.0	28	3.20	56
258	3.05	East river, midstream, at Brooklyn Bridge..........................	40 42 20	73 59 48	20	Slack	19.0	28	3.34	58
259	3.20	East river, midstream, at Brooklyn Bridge..........................	40 42 20	73 59 48	40	Slack	18.5	28	3.86	65

TABLE XXI—Continued

22—EAST RIVER COURSE FROM BROOKLYN BRIDGE TO HELL GATE. JULY 3, 1909

Low water occurred at Governor's Island at 2.27 P. M. The wind was northwest with a velocity of 40 miles per hour.

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal curren	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. sa ura-tion
			° ′ ″	° ′ ″						
260	8.30	East river, midstream, at Brooklyn Bridge	40 42 20	73 59 48	1	Flood	19.0	20	4.08	72
261	8.35	East river, midstream, at Brooklyn Bridge	40 42 20	73 59 48	20	Flood	19.0	20	4.15	73
262	8.40	East river, midstream, at Brooklyn Bridge	40 42 20	73 59 48	40	Flood	18.5	20	4.25	73
263	8.50	East river, midstream, at Williamsburg Bridge	40 42 49	73 58 21	1	Flood	19.0	20	3.79	67
264	8.55	East river, midstream, at Williamsburg Bridge	40 42 49	73 58 21	40	Flood	18.5	20	4.15	71
265	9.05	East River, midstream, opposite East 23d street	40 44 00	73 58 05	1	Flood	19.0	20	3.79	68
266	9.10	East river, midstream, opposite East 23d street	40 44 00	73 58 05	20	Flood	19.0	20	3.56	62
267	9.15	East river, midstream, opposite East 23d street	40 44 00	73 58 05	40	Flood	18.0	20	4.25	73
268	9.25	East river, midstream, opposite East 42d street	40 44 50	73 57 55	1	Flood	19.0	20	3.86	68
269	9.30	East river, midstream, opposite East 42d street	40 44 50	73 57 55	40	Flood	18.0	20	3.95	68
270	9.40	East river, midstream, west channel at Queensboro Bridge	40 45 25	73 57 30	1	Flood	19.0	20	3.56	62
271	9.45	East river, midstream, west channel at Queensboro Bridge	40 45 25	73 57 30	30	Flood	19.0	20	3.95	68
272	9.50	East river, midstream, west channel at Queensboro Bridge	40 45 25	73 57 30	70	Flood	18.0	20	4.08	70
273	10.00	East river, opposite East 80th street	40 46 10	73 56 50	1	Flood	19.0	20	3.26	58
274	10.05	East river, opposite East 80th street	40 46 10	73 56 50	60	Flood	18.0	20	3.34	58
275	10.15	East river, midstream, opposite East 92d street	40 46 50	73 56 25	1	Flood	19.0	20	3.50	63
276	10.20	East river, midstream, opposite East 92d street	40 46 50	73 56 25	30	Flood	18.5	20	3.26	57
277	10.25	East river, midstream, opposite East 92d street	40 46 50	73 56 25	60	Flood	18.0	20	3.67	63

23—HUDSON RIVER COURSE FROM MT. ST. VINCENT TO YONKERS. JULY 7, 1909

High water occurred at Governor's Island at 11.18 A. M. The wind was east with a velocity of 5 miles per hour.

278	A. M. 11.40	Opposite Mt. St. Vincent, 100 feet off shore	40 54 50	73 54 41	1	Flood	20.5	64	4.75	79
279	12.00	Opposite Mt. St. Vincent, 100 feet off shore	40 54 50	73 54 41	8	Flood	20.5	64	4.56	76
280	P. M. 12.20	Opposite Ludlow station, 200 feet off shore	40 55 35	73 54 30	1	Flood	20.5	64	4.75	79
281	12.30	Opposite Ludlow station, 200 feet off shore	40 55 35	73 54 30	10	Flood	20.5	64	4.25	71
282	12.50	Opposite Sugar Refinery, Yonkers, 200 feet off shore	40 55 47	73 54 25	1	Flood	20.5	64	4.45	74
283	1.00	Opposite Sugar Refinery, Yonkers, 200 feet off shore	40 55 47	73 54 25	10	Flood	20.5	64	3.95	66
284	1.20	Opposite recreation pier, Yonkers, 200 feet off shore	40 56 15	73 54 20	1	Flood	21.0	64	3.86	64
285	1.30	Opposite recreation pier, Yonkers, 200 feet off shore	40 56 15	73 54 20	20	Flood	20.5	64	3.64	61

TABLE XXI—Continued

23—HUDSON RIVER COURSE FROM MT. ST. VINCENT TO YONKERS. JULY 7, 1909—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
286	3.20	Opposite Mt. St. Vincent, 100 feet off shore	40 54 50	73 54 41	1	Ebb	21.0	68	3.68	63
287	3.30	Opposite Mt. St. Vincent, 100 feet off shore	40 54 50	73 54 41	8	Ebb	21.0	68	3.64	60
288	3.50	Opposite Riverdale, 200 feet off shore	40 54 10	73 54 55	1	Ebb	21.0	68	3.86	63
289	4.00	Opposite Riverdale, 200 feet off shore	40 54 10	73 54 55	10	Ebb	21.0	68	3.64	60
290	4.20	Opposite Spuyten Duyvil, 200 feet off drawbridge	40 52 50	73 55 25	1	Ebb	21.0	68	3.56	58
291	4.30	Opposite Spuyten Duyvil, 200 feet off drawbridge	40 52 50	73 55 25	20	Ebb	21.0	68	3.34	55
292	4.50	Opposite Inwood station, 200 feet off shore	40 52 20	73 55 50	1	Ebb	21.0	68	3.71	61
293	5.00	Opposite Inwood station, 200 feet off shore	40 52 20	73 55 50	10	Ebb	21.0	68	3.34	55

24—GRAVESEND BAY. JULY 9, 1909

High water occurred at Governor's Island at 1.03 P. M. The wind was southeast with a velocity of 5 miles per hour.

294	P. M. 12.30	Gravesend bay, 200 feet off Marine Basin	40 36 10	74 00 50	1	Flood	20.5	12	5.34	99
295	12.40	Gravesend bay, 200 feet off Marine Basin	40 36 10	74 00 50	10	Flood	20.5	12	5.47	101
296	1.00	Gravesend bay, 200 feet off Atlantic Yacht Club	40 35 35	74 00 00	1	Flood	20.5	12	5.34	99
297	1.10	Gravesend bay, 200 feet off Atlantic Yacht Club	40 35 35	74 00 00	10	Flood	20.5	12	5.77	107
298	1.30	Coney Island creek, at mouth	40 34 45	73 59 20	1	Flood	20.5	12	1.78	33
299	2.15	Coney Island creek, foot of 12th street, Coney Island	40 34 55	73 58 55	1	Ebb	21.0	12	3.86	73
300	3.10	Coney Island creek, foot of 17th street, Coney Island	40 34 55	73 59 05	1	Ebb	21.0	12	3.86	73
301	3.40	Gravesend bay, foot of 22d street, Coney Island	40 34 50	73 59 35	1	Ebb	22.0	12	0.59	11
302	4.30	Gravesend bay, foot of 24th street, Coney Island	40 34 45	73 59 40	1	Ebb	21.5	12	1.19	22
303	5.00	Gravesend bay, 200 feet off Atlantic Yacht Club	40 35 35	74 00 00	1	Ebb	20.5	12	3.86	72

25—GRAVESEND BAY. JULY 10, 1909

High water occurred at Governor's Island at 2.11 P. M. The wind was southwest with a velocity of 5 miles per hour.

304	A. M. 9.45	Off Ulmer Park, end of dock	40 35 25	73 59 50	1	Flood	19.0	12	4.45	81
305	10.15	Off Bay Yacht Club, end of dock	40 36 10	74 00 55	1	Flood	19.0	12	4.45	81
306	10.40	500 feet off Avon Beach Hotel	40 36 00	74 00 20	1	Flood	19.0	12	4.75	86
307	11.10	100 feet off Fort Lowry Hotel dock	40 35 50	74 00 10	1	Flood	19.0	12	4.75	86
308	11.50	Outer end of Marine Basin	40 36 10	74 01 05	1	Flood	19.0	12	5.04	92
309	P. M. 12.20	By breakwater north of Coney Island creek	40 35 00	73 59 30	1	Flood	19.0	12	4.45	81
310	1.05	Foot of 22d street, Coney Island	40 34 50	73 59 35	1	Flood	19.0	12	1.19	12

TABLE XXI—Continued

26—THE NARROWS. JULY 10, 1909

High water occurred at Governor's Island at 2.11 P. M. The wind was southeast with a velocity of 5 miles per hour.

Sample No.	Hour P. M.	Location of Samples: Approximate	Location of Samples: Latitude ° ′ ″	Location of Samples: Longitude ° ′ ″	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen: C. C. per litre	Oxygen: Per cent. saturation
311	1.30	Narrows, near Fort Lafayette	40 36 29	74 02 25	1	Flood	19.0	12	5.34	97
312	1.40	Narrows, near Fort Lafayette	40 36 29	74 02 25	40	Flood	19.0	12	5.04	92
313	2.00	Narrows, near Fort Lafayette	40 36 29	74 02 25	90	Flood	18.5	12	4.75	85

27—SANDY HOOK BAY AND SHREWSBURY RIVER. JULY 13, 1909

High water occurred at Governor's Island at 5.13 P. M. The wind was southeast with a velocity of 5 miles per hour.

	A. M.									
314	11.40	Sandy Hook bay, near Shrewsbury river	40 27 50	74 01 25	1	Flood	20.5	16	6.23	113
315	11.50	Sandy Hook bay, near Shrewsbury river	40 27 50	74 01 25	30	Flood	20.0	16	6.28	114
	P. M.									
316	12.20	Shrewsbury river, at Spermaceti avenue	40 24 55	73 59 35	1	Flood	22.0	28	6.23	113
317	1.15	Shrewsbury river at Highland Landing	40 23 50	73 58 45	1	Flood	23.0	28	5.93	108
318	2.05	Navesink river, near mouth	40 22 50	73 59 15	1	Flood	23.0	28	5.34	97
319	2.30	Shrewsbury river, opposite mouth of Navesink river	40 22 45	73 58 45	1	Flood	24.0	32	5.64	106
320	3.00	Shrewsbury river at Seabright	40 21 55	73 58 40	1	Flood	25.0	32	5.64	106
321	3.45	Sandy Hook bay, middle of bend of horse shoe	40 26 45	73 59 50	1	Flood	20.5	20	6.23	113
322	4.10	Sandy Hook bay, west of point of Sandy Hook	40 28 35	74 01 25	1	Flood	20.5	20	5.93	108
323	4.20	Sandy Hook bay, west of point of Sandy Hook	40 28 35	74 01 25	40	Flood	20.0	20	5.64	103

28—LOWER BAY. JULY 13, 1909

High water occurred at Governor's Island at 5.13 P. M. The wind was southeast with a velocity of 5 miles per hour.

	P. M.									
324	4.35	Lower bay, near buoy 8 in Main Channel	40 28 45	74 01 25	1	Flood	20.5	16	6.23	113
325	4.40	Lower bay, near buoy in Main Channel	40 28 45	74 01 25	40	Flood	20.0	16	6.08	111
326	5.00	Lower bay, midway between buoy 8 and Romer light	40 29 50	74 01 00	1	Flood	20.5	16	6.23	113
327	5.10	Lower bay, midway between buoy 8 and Romer light	40 29 50	74 01 00	40	Flood	20.0	16	6.08	111

29—LOWER BAY. JULY 14, 1909

Low water occurred at Governor's Island at 11.52 A. M. The wind was southeast with a velocity of 5 miles per hour.

	A. M.									
328	9.15	Just inside bell buoy off Sea Gate Inn	40 34 15	73 59 50	1	Ebb	19.5	16	4.45	80
329	9.35	Just outside bell buoy off Sea Gate Inn	40 34 05	73 59 50	1	Ebb	19.5	16	4.15	74
330	10.00	On East Bank	40 32 25	73 59 45	1	Ebb	19.5	16	4.45	80
331	10.30	In 14-foot channel, near buoy A. C. 16	40 31 50	74 00 25	1	Ebb	19.5	16	4.75	85
332	11.00	On Romer shoals	40 31 20	74 00 35	1	Ebb	19.5	16	4.75	85
333	11.15	In Swash channel, 700 feet southwest of Romer light	40 30 40	74 00 50	1	Ebb	19.5	16	5.04	90
334	11.25	In Swash channel, 700 feet southwest of Romer light	40 30 40	74 00 50	30	Ebb	19.0	16	5.17	92
335	11.55	In Swash channel, near junction with Main channel	40 31 20	74 02 15	1	Ebb	19.5	16	5.04	90

TABLE XXI—Continued

29—LOWER BAY. JULY 14, 1909—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ' ''	° ' ''						
336	12.05	In Swash channel, near junction with Main channel	40 31 20	74 02 15	30	Ebb	19.0	16	5.34	95
337	1.00	In Main Ship channel, near junction with Swash channel	40 31 20	74 02 30	1	Flood	19.5	16	5.17	92
338	1.10	In Main Ship channel, near junction with Swash channel	40 31 20	74 02 30	40	Flood	19.0	16	5.34	95
339	2.00	500 feet west of West Bank light	40 32 15	74 02 45	1	Flood	19.5	16	5.04	90
340	2.50	Midway between West Bank light and Elm Tree beacon	40 33 05	73 04 10	1	Flood	19.5	16	5.17	92
341	3.30	1,000 feet off Elm Tree beacon	40 33 45	74 05 30	1	Flood	20.0	16	4.75	86

30—HARLEM RIVER COURSE FROM WARD'S ISLAND TO SPUYTEN DUYVIL. JULY 15, 1909

Low water occurred at Governor's Island at 12.56 P. M. The wind was southeast with a velocity of 5 miles per hour.

	P. M.									
342	12.30	Opposite East 109th street, midstream	40 47 23	73 56 07	1	Ebb	21.0	36	1.19	21
343	12.40	Opposite East 109th street, midstream	40 47 23	73 56 07	20	Ebb	21.0	36	1.21	22
344	1.05	At Third Avenue Bridge, midstream	40 48 25	73 55 58	1	Ebb	21.0	36	1.78	32
345	1.15	At Third Avenue Bridge, midstream	40 48 25	73 55 58	20	Ebb	21.0	36	1.82	33
346	1.25	At 155th Street Bridge, midstream	40 49 40	73 56 03	1	Ebb	21.0	36	2.37	42
347	1.35	At 155th Street Bridge, midstream	40 49 40	73 56 03	20	Ebb	21.0	36	2.43	43
348	1.50	At 207th Street Bridge, midstream	40 51 46	73 54 54	1	Ebb	21.0	36	2.67	46
349	1.55	At 207th Street Bridge, midstream	40 51 46	73 54 54	16	Ebb	20.0	36	2.73	47
350	2.15	200 feet east of Spuyten Duyvil drawbridge, midstream	40 52 42	73 55 28	1	Ebb	21.0	36	3.26	56
351	2.20	200 feet east of Spuyten Duyvil drawbridge, midstream	40 52 42	73 55 28	16	Ebb	20.0	36	3.34	58
352	3.30	200 feet east of Spuyten Duyvil drawbridge, midstream	40 52 42	73 55 28	1	Flood	21.0	64	4.75	79
353	3.35	200 feet east of Spuyten Duyvil drawbridge, midstream	40 52 42	73 55 28	16	Flood	21.0	64	4.41	74
354	3.45	At 207th Street Bridge, midstream	40 51 46	73 54 54	1	Flood	21.0	44	3.26	57
355	3.50	At 207th Street Bridge, midstream	40 51 46	73 54 54	16	Flood	21.0	44	3.34	59
356	4.10	At 155th Street Bridge, midstream	40 49 40	73 56 03	1	Flood	21.5	36	2.97	53
357	4.15	At 155th Street Bridge, midstream	40 49 40	73 56 03	20	Flood	21.0	36	3.04	54
358	4.35	At Third Avenue Bridge, midstream	40 48 25	73 55 58	1	Flood	21.5	32	2.67	48
359	4.40	At Third Avenue Bridge, midstream	40 48 25	73 55 58	20	Flood	21.0	32	2.73	49
360	4.50	Opposite East 109th street, midstream	40 47 23	73 56 07	1	Flood	21.0	32	2.08	37
361	4.55	Opposite East 109th street, midstream	40 47 23	73 56 07	20	Flood	21.0	32	2.13	38

31—UPPER BAY AND THE NARROWS. JULY 16, 1909

Low water occurred at Governor's Island at 1.27 P. M. The wind was southeast with a velocity of 10 miles per hour.

	A. M.									
362	11.30	Midway between Battery and Governor's Island	40 41 50	74 01 00	1	Ebb	20.5	28	3.26	58
363	11.40	Midway between Battery and Governor's Island	40 41 50	74 01 00	30	Ebb	20.0	28	3.34	59
364	11.40	Midway between Battery and Governor's Island	40 41 50	74 01 00	60	Ebb	19.0	28	3.67	63
	P. M.									
365	1.00	Near buoy G. 2, north of Robbin's Reef	40 40 12	74 03 10	1	Ebb	20.5	28	3.56	64
366	1.10	Near buoy G. 2, north of Robbin's Reef	40 40 12	74 03 10	20	Ebb	20.5	28	3.67	64
367	1.20	Near buoy G. 2, north of Robbin's Reef	40 40 12	74 03 10	50	Ebb	19.0	28	3.50	60

TABLE XXI—Continued

31—UPPER BAY AND THE NARROWS. JULY 16, 1909—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
368	1.50	Narrows, midway between forts......	40 36 25	74 02 48	1	Ebb	20.5	28	3.86	67
369	2.00	Narrows, midway between forts......	40 36 25	74 02 48	40	Ebb	20.0	28	3.95	70
370	2.10	Narrows, midway between forts......	40 36 25	74 02 48	80	Ebb	19.0	28	3.79	65
371	4.10	Narrows, midway between forts......	40 36 25	74 02 48	1	Flood	20.0	20	4.45	81
372	4.20	Narrows, midway between forts......	40 36 25	74 02 48	40	Flood	19.5	20	4.56	81
373	4.30	Narrows, midway between forts......	40 36 25	74 02 48	80	Flood	19.0	20	4.37	78
374	4.45	Near buoy G. 2, north of Robbin's Reef	40 40 12	74 03 10	1	Flood	20.0	20	4.15	76
375	4.50	Near buoy G. 2, north of Robbin's Reef	40 40 12	74 03 10	20	Flood	19.5	20	4.25	76
376	4.55	Near buoy G. 2, north of Robbin's Reef	40 40 12	74 03 10	50	Flood	19.0	20	4.08	73
377	5.20	Midway between Battery and Governor's Island......................	40 41 50	74 01 00	1	Flood	20.0	28	3.86	68
378	5.22	Midway between Battery and Governor's Island......................	40 41 50	74 01 00	30	Flood	19.5	28	3.95	69
379	5.25	Midway between Battery and Governor's Island......................	40 41 50	74 01 00	60	Flood	19.0	28	3.80	66

32—KILL VAN KULL. JULY 17, 1909

Low water occurred at Governor's Island at 2.21 P. M. The wind was east with a velocity of 5 miles per hour.

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
	A. M.									
380	9.30	Upper bay, off Tompkinsville........	40 38 20	74 04 15	1	Ebb	21.0	28	3.95	72
381	9.40	Upper bay, off Tompkinsville........	40 38 20	74 04 15	40	Ebb	20.0	28	4.15	73
382	10.10	Kill van Kull, west end.............	40 38 30	74 08 40	1	Ebb	21.0	28	4.56	85
383	10.20	Kill van Kull, west end.............	40 38 30	74 08 40	20	Ebb	20.0	28	4.75	86
384	10.35	Kill van Kull, off Port Richmond.....	40 38 35	74 08 00	1	Ebb	21.0	28	4.56	83
385	10.45	Kill van Kull, off Port Richmond.....	40 38 35	74 08 00	20	Ebb	20.0	28	4.45	81
386	11.00	Bodine creek at mouth..............	40 38 20	74 07 35	1	Ebb	22.0	28	3.86	70

33—UPPER BAY. JULY 17, 1909

Low water occurred at Governor's Island at 2.21 P. M. The wind was east with a velocity of 5 miles per hour.

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
	A. M.									
387	11.25	At end of pier, foot of 65th street, Brooklyn........................	40 38 40	74 01 55	1	Ebb	21.0	28	2.08	38
388	11.35	At end of pier, foot of 65th street, Brooklyn........................	40 38 40	74 01 55	20	Ebb	20.0	28	2.43	44
389	11.45	By buoy off Gowanus bay...........	40 39 30	74 01 35	1	Ebb	21.0	28	2.08	38
390	11.50	By buoy off Gowanus bay...........	40 39 30	74 01 35	20	Ebb	21.0	28	2.13	39
391	12.00 P. M.	Off Atlantic docks in Buttermilk channel..............................	40 41 05	74 00 50	1	Ebb	21.0	28	3.26	59
392	12.05	Off Atlantic docks in Buttermilk channel..............................	40 41 05	74 00 50	40	Ebb	20.0	28	3.34	59
393	12.15	500 feet northeast of Ellis Island.....	40 41 55	74 02 15	1	Ebb	21.0	28	3.26	59
394	12.20	500 feet northeast of Ellis Island.....	40 41 55	74 02 15	30	Ebb	20.0	28	3.64	64

34—UPPER BAY, NARROWS AND LOWER BAY. JULY 20, 1909

Low water occurred at Governor's Island at 4.27 P. M. The wind was southeast with a velocity of 5 miles per hour.

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
	A. M.									
395	11.45	Upper bay, near bell buoy just south of Governor's Island.................	40 40 55	74 01 35	1	Ebb	20.5	20	3.20	58
396	11.50	Upper bay, near bell buoy just south of Governor's Island.................	40 40 55	74 01 35	40	Ebb	19.5	20	3.34	60

TABLE XXI—Continued

34—UPPER BAY, NARROWS AND LOWER BAY. JULY 20, 1909—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude ° ′ ″	Longitude ° ′ ″					C. C. per litre	Per cent. saturation
397	12.25	Upper bay, ¼ mile east of Robbin's Reef light	40 39 30	74 03 37	1	Ebb	20.5	20	3.50	64
398	12.30	Upper bay, ¼ mile east of Robbin's Reef light	40 39 30	74 03 37	40	Ebb	19.0	20	3.65	65
399	12.45	Narrows, midway between forts	40 36 25	74 02 48	1	Ebb	20.0	20	3.80	69
400	12.50	Narrows, midway between forts	40 36 25	74 02 48	40	Ebb	19.0	20	3.95	71
401	2.50	Lower bay, 500 feet off Norton's Point	40 34 35	74 00 50	1	Ebb	20.0	16	4.37	80
402	2.55	Lower bay, 500 feet off Norton's Point	40 34 35	74 00 50	40	Ebb	19.0	16	4.56	81

35—LOWER BAY JULY 21, 1909

High water occurred at Governor's Island at 11.03 A. M. The wind was southeast with a velocity of 5 miles per hour.

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
	A. M.									
403	8.10	Lower bay, 500 feet off Norton's Point	40 34 35	74 00 50	1	Flood	19.0	12	5.00	91
404	8.15	Lower bay, 500 feet off Norton's Point	40 34 35	74 00 50	20	Flood	19.0	12	5.05	92
405	9.15	Lower bay, near buoy A. C. 5	40 30 15	73 57 40	1	Flood	18.0	8	6.23	111
406	9.20	Lower bay, near buoy A. C. 5	40 30 15	73 57 40	40	Flood	18.0	8	6.12	109

36—ATLANTIC OCEAN. JULY 21, 1909

High water occurred at Governor's Island at 11.03 A. M. The wind was southeast with a velocity of 5 miles per hour.

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
	P. M.									
407	12.15	Ocean, 10 miles off Long Branch in "mud gorge"	40 19 15	73 48 45	1	Flood	18.0	—	6.23	111
408	12.20	Ocean, 10 miles off Long Branch in "mud gorge"	50 19 15	73 48 45	145	Flood	14.0	—	5.93	100
409	1.00	Ocean, 12 miles off Long Branch in "mud gorge"	40 19 15	73 47 15	1	Flood	18.0	—	6.20	111
410	1.20	Ocean, 12 miles off Long Branch in "mud gorge"	40 19 15	73 47 15	150	Flood	14.0	—	5.83	99
411	2.45	Ocean, at "oil spot" off Sandy Hook	40 27 00	73 58 25	1	Ebb	19.0	4	6.23	115
412	2.50	Ocean, at "oil spot" off Sandy Hook	40 27 00	73 58 25	20	Ebb	19.0	4	6.23	115
413	3.00	Ocean, at "oil spot" off Sandy Hook	40 27 05	73 58 25	1	Ebb	19.0	4	6.23	115
414	3.05	Ocean, at "oil spot" off Sandy Hook	40 27 05	73 58 25	20	Ebb	19.0	4	6.23	115
415	3.30	Ocean, near buoy 5 off Sandy Hook	40 28 45	73 59 50	1	Ebb	19.0	8	6.23	111
416	3.35	Ocean, near buoy 5 off Sandy Hook	40 28 45	73 59 50	40	Ebb	18.0	8	6.07	110
417	4.05	Lower bay, near buoy A. C. 10	40 30 55	73 58 50	1	Ebb	19.0	12	6.00	107
418	4.10	Lower bay, near buoy A. C. 10	40 30 55	73 58 50	40	Ebb	18.0	12	5.95	106

37—THE NARROWS. JULY 21, 1909

High water occurred at Governor's Island at 11.03 A. M. The wind was southeast, with a velocity of 5 miles per hour.

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
	P. M.									
419	4.45	Narrows, midway between forts	40 36 25	74 02 48	1	Ebb	19.0	12	4.15	74
420	4.50	Narrows, midway between forts	40 36 25	74 02 48	40	Ebb	18.0	12	4.25	76

38—UPPER BAY. JULY 21, 1909

High water occurred at Governor's Island at 11.03 A. M. The wind was southeast with a velocity of 5 miles per hour.

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
	P. M.									
421	5.25	Upper bay, 1000 feet off Erie Basin	40 40 20	74 01 20	1	Ebb	19.5	16	3.56	64
422	5.30	Upper bay, 1000 feet off Erie Basin	40 40 20	74 01 20	20	Ebb	18.5	16	3.64	65

TABLE XXI—Continued

39—HUDSON RIVER, UPPER BAY AND LOWER BAY. JULY 22, 1909

High water occurred at Governor's Island at 11.53 A. M. The wind was south with a velocity of 5 miles per hour.

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
423	10.20	Hudson river, midstream, off Gansevoort street	40 44 35	74 01 10	1	Flood	20.5	36	3.58	63
424	10.25	Hudson river, midstream, off Gansevoort street	40 44 35	74 01 10	60	Flood	19.0	36	3.65	63
425	10.45	Hudson river, midstream, off Desbrosses street	40 43 30	74 01 15	1	Flood	20.5	36	3.80	67
426	10.48	Hudson river, midstream, off Desbrosses street	40 43 30	74 01 15	20	Flood	20.0	36	3.86	67
427	10.52	Hudson river, midstream, off Desbrosses street	40 43 30	74 01 15	40	Flood	20.0	36	3.95	70
428	11.20	Hudson river, midstream, off Pier A	40 42 19	74 01 34	1	Flood	20.5	32	3.80	68
429	11.25	Hudson river, midstream, off Pier A	40 42 19	74 01 34	40	Flood	20.0	32	3.58	64
430	11.40	Upper bay, 500 feet east of Liberty Island	40 41 20	74 02 25	1	Flood	20.0	28	3.66	64
431	11.43	Upper bay, 500 feet east of Liberty Island	40 41 20	74 02 25	20	Flood	20.0	28	3.56	63
432	11.48 P. M.	Upper bay, 500 feet east of Liberty Island	40 41 20	74 02 25	50	Flood	19.5	28	3.50	61
433	12.10	Upper bay, near bell buoy G. 2	40 40 12	74 03 10	1	Flood	20.0	28	3.80	67
434	12.13	Upper bay, near bell buoy G. 2	40 40 12	74 03 10	50	Flood	19.5	28	3.95	70
435	12.25	Upper bay, near Robbin's Reef bell buoy	40 39 10	74 03 50	1	Flood	20.0	20	3.95	72
436	12.27	Upper bay, near Robbin's Reef bell buoy	40 39 10	74 03 50	30	Flood	19.5	20	4.25	74
437	12.30	Upper bay, near Robbin's Reef bell buoy	40 39 10	74 03 50	60	Flood	19.5	20	4.08	73
438	12.50	Narrows, midway between forts	40 36 25	74 02 48	1	Flood	20.0	16	4.45	81
439	12.55	Narrows, midway between forts	40 36 25	74 02 48	90	Flood	19.0	16	4.37	78
440	1.15	Lower bay, 500 feet off Norton's Point	40 34 35	74 00 50	1	Flood	20.0	16	4.56	83

40—LOWER BAY, UPPER BAY AND HUDSON RIVER. JULY 22, 1909

Lower water occurred at Governor's Island at 5.51 P. M. The wind was south with a velocity of 5 miles per hour.

	P. M.									
441	2.45	Lower bay, 500 feet off Norton's Point	40 34 35	74 00 50	1	Ebb	20.5	20	4.34	79
442	3.05	Narrows, midway between forts	40 36 25	74 02 48	1	Ebb	20.5	20	3.80	70
443	3.10	Narrows, midway between forts	40 36 25	74 02 48	90	Ebb	19.0	20	3.86	70
444	3.30	Upper bay, near Robbin's Reef bell buoy	40 39 10	74 03 50	1	Ebb	20.5	28	3.80	68
445	3.32	Upper bay, near Robbin's Reef bell buoy	40 39 10	74 03 50	30	Ebb	20.0	28	3.95	69
446	3.37	Upper bay, near Robbin's Reef bell buoy	40 39 10	74 03 50	60	Ebb	20.0	28	3.56	62
447	3.50	Upper bay, near bell buoy G. 2	40 40 12	74 03 10	1	Ebb	20.5	28	3.86	70
448	3.55	Upper bay, near bell buoy G. 2	40 40 12	74 03 10	50	Ebb	19.5	28	3.95	68
449	4.05	Upper bay, 500 feet east of Liberty Island	40 41 20	74 02 25	1	Ebb	20.5	28	3.20	57
450	4.07	Upper bay, 500 feet east of Liberty Island	40 41 20	74 02 25	20	Ebb	20.0	28	3.26	57
451	4.10	Upper bay, 500 feet east of Liberty Island	40 41 20	74 02 25	50	Ebb	19.5	28	3.34	59
452	4.18	Hudson river, midstream, opposite Pier A	40 42 19	74 01 34	1	Ebb	20.5	32	3.20	57

TABLE XXI—Continued

40—LOWER BAY, UPPER BAY AND HUDSON RIVER. JULY 22, 1909—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
453	4.21	Hudson river, midstream, opposite Pier A	40 42 19	74 01 34	40	Ebb	20.0	32	3.34	59
454	4.35	Hudson river, midstream, off Desbrosses street	40 43 30	74 01 15	1	Ebb	20.5	32	3.50	63
455	4.37	Hudson river, midstream, off Desbrosses street	40 43 30	74 01 15	20	Ebb	20.5	32	3.58	64
456	4.40	Hudson river, midstream, off Desbrosses street	40 43 30	74 01 15	40	Ebb	20.0	32	3.65	64
457	4.50	Hudson river, midstream, off Gansevoort street	40 44 35	74 01 10	1	Ebb	20.5	32	3.80	68
458	4.53	Hudson river, midstream, off Gansevoort street	40 44 35	74 01 10	60	Ebb	19.5	32	3.86	68

41—UPPER BAY AND EAST RIVER. JULY 24, 1909

High water occurred at Governor's Island at 12.53 P. M. The wind was north with a velocity of 30 miles per hour.

459	A. M. 9.05	200 feet off east dock on Governor's Island	40 41 35	74 00 50	1	Flood	20.5	28	3.26	58
460	9.08	200 feet off east dock on Governor's Island	40 41 35	74 00 50	40	Flood	19.5	28	3.34	59
461	9.15	200 feet off Pier 38, Brooklyn	40 40 40	74 01 15	1	Flood	20.5	28	2.97	53
462	9.18	200 feet off Pier 38, Brooklyn	40 40 40	74 01 15	40	Flood	19.5	28	3.04	53
463	9.28	500 feet off Beards, Erie Basin in Upper Bay	40 40 20	74 01 15	1	Flood	20.5	28	3.56	62
464	9.30	500 feet off Beards, Erie Basin in Upper Bay	40 40 20	74 01 15	30	Flood	19.5	28	3.67	64
465	10.00	100 feet off Pier 10, Brooklyn	40 41 55	73 59 55	1	Flood	20.5	28	3.26	58
466	10.05	100 feet off Pier 10, Brooklyn	40 41 55	73 59 55	40	Flood	19.5	28	3.20	56
467	10.25	Foot of Oliver street, Manhattan, pierhead line	40 42 30	73 59 50	1	Flood	20.5	28	1.82	33
468	10.30	Foot of Oliver street, Manhattan, pierhead line	40 42 30	73 59 50	20	Flood	20.0	28	2.90	51
469	10.55	Foot of Corlears street, Manhattan	40 42 35	73 58 45	1	Flood	20.5	28	3.56	62
470	11.00	Foot of Corlears street, Manhattan	40 42 35	73 58 45	20	Flood	20.0	28	3.67	64

42—HUDSON RIVER. JULY 26, 1909

High water occurred at Governor's Island at 3 P. M. Ebb current ran down the river practically all day. The wind was north with a velocity of 10 miles per hour.

471	A. M. 11.00	500 feet off Pier 4	40 42 25	74 01 10	1	Ebb	20.0	36	3.26	58
472	11.05	500 feet off Pier 4	40 42 25	74 01 10	40	Ebb	19.0	36	3.34	58
473	11.20	500 feet off foot West 23d street	40 45 09	74 00 45	1	Ebb	20.0	52	3.56	61
474	11.25	500 feet off foot West 23d street	40 45 09	74 00 45	40	Ebb	19.0	52	3.65	62
475	11.40	500 feet off foot West 59th street	40 46 25	73 59 45	1	Ebb	20.0	52	3.50	60
476	11.43	500 feet off foot West 59th street	40 46 25	73 59 45	40	Ebb	19.0	52	3.56	60
477	12.00	500 feet off foot West 96th street	40 47 50	73 58 40	1	Slack	20.0	52	3.26	56
478	P. M. 12.05	500 feet off foot West 96th street	40 47 50	73 58 40	40	Slack	19.0	52	3.50	60
479	12.25	500 feet off foot West 108th street	40 48 20	73 58 25	1	Slack	20.5	64	3.86	64
480	12.30	500 feet off foot West 108th street	40 48 20	73 58 25	20	Slack	19.5	64	3.95	66
481	3.00	At foot of West 155th street, Washington Heights baths	40 50 00	73 57 05	1	Ebb	21.0	64	4.15	69
482	3.15	At foot of West 149th street, Manhattan baths	40 49 45	73 57 15	1	Ebb	21.0	64	4.08	68
483	3.25	At foot of West 136th street	40 49 20	73 57 20	1	Ebb	21.0	64	3.95	66

TABLE XXI—Continued

43—HUDSON RIVER. AUGUST 19, 1909

High water occurred at Governor's Island at 10.44 A. M. The wind was south with a velocity of 5 miles per hour.

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
484	9.15	Hudson river, midstream, opposite Pier 1, Manhattan	40 42 25	74 01 35	1	Flood	21.5	20	3.58	66
485	9.20	Hudson river, midstream, opposite Pier 1, Manhattan	40 42 25	74 01 35	50	Flood	20.5	20	3.65	66
486	9.40	Hudson river, 1000 feet off Pier 17, Manhattan	40 43 05	74 01 25	1	Flood	21.5	20	3.26	60
487	9.45	Hudson river, 1000 feet off Pier 17, Manhattan	40 43 05	74 01 25	20	Flood	21.0	28	3.34	61
488	9.50	Hudson river, 1000 feet off Pier 17, Manhattan	40 43 05	74 01 25	40	Flood	20.5	28	3.56	64
489	11.00	Hudson river, midstream, opposite Pier 32, Manhattan	40 43 40	74 01 15	1	Flood	21.5	28	3.20	55
490	11.05	Hudson river, midstream, opposite Pier 32, Manhattan	40 43 40	74 01 15	40	Flood	21.0	28	3.34	61
491	11.30	Hudson river, midstream, opposite Pier 48, Manhattan	40 44 05	74 01 25	1	Flood	21.5	28	3.26	55
492	11.35	Hudson river, midstream, opposite Pier 48, Manhattan	40 44 05	74 01 25	20	Flood	21.0	28	3.34	61
493	11.40	Hudson river, midstream, opposite Pier 48, Manhattan	40 44 05	74 01 25	40	Flood	20.5	28	3.58	64

44—HUDSON RIVER COURSE FROM 42d STREET TO YONKERS. SEPTEMBER 7, 1909

High water occurred at Governor's Island at 2.38 P. M. The wind was southeast, with a velocity of 10 miles per hour.

	A. M.									
494	10.20	500 feet off foot West 42d street	40 45 45	74 00 15	1	Ebb	21.0	52	3.76	65
495	10.25	500 feet off foot West 42d street	40 45 45	74 00 15	35	Ebb	20.5	52	3.82	66
496	10.55	500 feet off foot West 72d street	40 46 55	73 59 25	1	Ebb	21.0	52	4.05	70
497	10.57	500 feet off foot West 72d street	40 46 55	73 59 25	20	Ebb	20.5	52	4.12	71
498	11.00	500 feet off foot West 72d street	40 46 55	73 59 25	35	Ebb	20.5	52	4.21	73
499	11.55	500 feet off foot West 110th street	40 48 20	73 58 25	1	Flood	21.0	52	4.12	71
500	12.00	500 feet off foot West 110th street	40 48 20	73 58 20	40	Flood	20.0	52	4.21	71
	P. M.									
501	12.15	500 feet off foot West 140th street	40 49 30	73 57 30	1	Flood	21.0	52	4.33	75
502	12.17	500 feet off foot West 140th street	40 49 30	73 57 30	20	Flood	20.5	52	4.41	76
503	12.20	500 feet off foot West 140th street	40 49 30	73 57 30	40	Flood	20.0	52	4.52	77
504	12.37	500 feet off Fort Washington Point	40 51 10	73 56 50	1	Flood	21.0	52	4.62	80
505	12.40	500 feet off Fort Washington Point	40 51 10	73 56 50	40	Flood	20.0	52	4.82	82
506	1.00	500 feet off Inwood bathing beach	40 52 20	73 55 55	1	Flood	21.0	52	4.91	85
507	1.02	500 feet off Inwood bathing beach	40 52 20	73 55 55	20	Flood	20.5	52	5.00	86
508	1.05	500 feet off Inwood bathing beach	40 52 20	73 55 55	40	Flood	20.0	52	5.12	87
509	1.20	500 feet off puyten Duyvil drawbridge	40 52 50	73 55 30	1	Flood	21.0	52	4.79	83
510	1.25	500 feet off Spuyten Duyvil drawbridge	40 52 50	73 55 30	40	Flood	20.0	52	4.91	83
511	1.45	500 feet off Riverdale station	40 54 15	73 55 00	1	Flood	21.0	52	5.72	99
512	1.48	500 feet off Riverdale station	40 54 15	73 55 00	20	Flood	20.5	52	5.29	91
513	1.52	500 feet off Riverdale station	40 54 15	73 55 00	40	Flood	20.0	52	5.20	88
514	2.15	500 feet off Federal refinery, Yonkers.	40 55 50	73 54 30	1	Flood	21.0	52	4.91	85
515	2.18	500 feet off Federal refinery, Yonkers.	40 55 50	73 54 30	40	Flood	20.0	52	5.12	87
516	2.40	500 feet off power plant, northern end of Yonkers	40 57 00	73 54 10	1	Flood	21.0	52	5.20	90
517	2.43	500 feet off power plant, northern end of Yonkers	40 57 00	73 54 10	20	Flood	21.0	52	5.29	91
518	2.45	500 feet off power plant, northern end of Yonkers	40 57 00	73 54 10	35	Flood	20.5	52	5.42	94

TABLE XXI—Continued

45—PASSAIC RIVER, NEWARK BAY AND KILL VAN KILL. SEPTEMBER 8, 1909

High water occurred at Governor's Island at 3.23 P. M. The wind was southeast with a velocity of 10 miles per hour.

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
519	1.30	Passaic river, near foot of N. J. R.R. avenue, Newark	40 44 49	74 09 55	1	Flood	22.0	52	0.00	0
520	1.32	Passaic river, near foot of N. J. R.R. avenue, Newark	40 44 49	74 09 55	10	Flood	21.5	52	0.00	0
521	2.17	Passaic river, 100 feet above P. R.R. freight bridge	40 44 10	74 09 45	1	Flood	21.5	40	2.02	36
522	2.20	Passaic river, 100 feet above P. R.R. freight bridge	40 44 10	74 09 45	10	Flood	21.0	40	2.06	36
523	2.40	Passaic river, near mouth	40 43 15	74 07 20	1	Flood	21.0	40	2.89	51
524	2.43	Passaic river, near mouth	40 43 15	74 07 20	10	Flood	20.5	40	2.94	52
525	3.00	Newark bay, near Lehigh Valley R.R. bridge	40 41 56	74 07 15	1	Flood	21.0	28	4.05	74
526	3.02	Newark bay, near Lehigh Valley R.R. bridge	40 41 56	74 07 15	10	Flood	20.5	28	4.12	74
527	3.23	Newark bay, near bell buoy off Centreville	40 40 15	74 08 10	1	Flood	21.0	28	3.76	68
528	3.25	Newark bay, near bell buoy off Centreville	40 40 15	74 08 10	10	Flood	20.5	28	4.12	72
529	3.40	Newark bay, near C. R.R. of N. J. drawbridge	40 39 17	74 08 46	1	Flood	20.5	28	3.76	67
530	3.42	Newark bay, near C. R.R. of N. J. drawbridge	40 39 17	74 08 46	15	Flood	20.5	28	3.82	67
531	3.45	Newark bay, near C. R.R. of N. J. drawbridge	40 39 17	74 08 46	30	Flood	20.0	28	3.91	69
532	4.00	Kill van Kull, west end	40 38 35	74 08 45	1	Flood	20.0	20	3.47	63
533	4.03	Kill van Kull, west end	40 38 35	74 08 45	35	Flood	20.0	20	3.61	66
534	4.25	Kill van Kull, opposite Sailors' Snug Harbor	40 38 50	74 06 25	1	Flood	19.5	20	3.76	67
535	4.27	Kill van Kull, opposite Sailors' Snug Harbor	40 38 50	74 06 25	20	Flood	19.0	20	3.82	68
536	4.30	Kill van Kull, opposite Sailors' Snug Harbor	40 38 50	74 06 25	40	Flood	19.0	20	4.21	75
537	4.40	Kill van Kull, opposite Constable Hook	40 39 05	74 05 15	1	Flood	20.0	20	4.12	75
538	4.43	Kill van Kull, opposite Constable Hook	40 39 05	74 05 15	40	Flood	19.0	20	4.52	81

46—EAST RIVER COURSE FROM BATTERY TO CLASON POINT. SEPTEMBER 9, 1909

Low water occurred at Governor's Island at 10.40 A. M. The wind was southeast with a velocity of 5 miles per hour.

	A. M.									
539	11.10	East river, midstream, off Battery	40 41 50	74 00 55	1	Ebb	20.0	32	3.18	56
540	11.12	East river, midstream, off Battery	40 41 50	74 00 55	20	Ebb	19.5	32	3.24	57
541	11.15	East river, midstream, off Battery	40 41 50	74 00 55	40	Ebb	19.0	32	3.91	68
542	11.35	East river, midstream, at Brooklyn Bridge	40 42 20	73 59 48	1	Ebb	20.0	32	3.18	56
543	11.38	East river, midstream, at Brooklyn Bridge	40 42 50	73 59 48	40	Ebb	19.0	32	3.53	61
544	11.54	East river, midstream, at Williamsburg Bridge	40 42 49	73 58 21	1	Ebb	20.0	32	3.47	61
545	11.57	East river, midstream, at Williamsburg Bridge	40 42 49	73 58 21	20	Ebb	19.5	32	3.53	62
546	12.00 P. M.	East river midstream, at Williamsburg Bridge	40 42 49	73 58 21	40	Ebb	19.0	32	3.61	62
547	12.14	East river, midstream, off East 23d street	40 44 00	73 58 05	1	Ebb	20.0	32	3.24	57

TABLE XXI—Continued

46—EAST RIVER COURSE FROM BATTERY TO CLASON POINT. SEPTEMBER 9, 1909—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
548	12.17	East river, midstream, off East 23d street	40 44 00	73 58 05	40	Ebb	19.0	32	3.61	62
549	12.25	East river, East channel, off East 49th street	40 45 00	73 57 30	1	Flood	20.0	32	3.47	61
550	12.27	East river, East channel, off East 49th street	40 45 00	73 57 30	20	Flood	19.0	32	3.82	66
551	12.30	East river, East channel, off East 49th street	40 45 00	73 57 30	40	Flood	19.0	32	3.91	67
552	12.42	East river, East channel, off East 70th street	40 45 45	73 56 50	1	Flood	20.0	32	3.47	61
553	12.45	East river, East channel, off East 70th street	40 45 45	73 56 50	30	Flood	19.0	32	3.53	61
554	12.55	East river, at Hell Gate	40 46 50	73 56 00	1	Flood	20.0	32	3.61	63
555	12.57	East river, at Hell Gate	40 46 50	73 56 00	20	Flood	19.5	32	3.82	67
556	1.00	East river, at Hell Gate	40 46 50	73 56 00	40	Flood	19.0	32	3.91	67
557	1.22	East river, between North and South Brother Islands	40 47 55	73 53 55	1	Flood	19.5	28	4.05	71
558	1.25	East river, between North and South Brother Island	40 47 55	73 53 55	40	Flood	19.0	28	4.52	78
559	1.50	East river, midstream, off Clason Point	40 48 00	73 50 40	1	Flood	19.0	28	4.33	75
560	1.55	East river, midstream, off Clason Point	40 48 00	73 50 40	30	Flood	19.0	28	4.52	78
561	2.00	East river, midstream, off Clason Point	40 48 00	73 50 40	70	Flood	18.5	28	4.41	75

47—LONG ISLAND SOUND. SEPTEMBER 9, 1909

Low water occurred at Governor's Island at 10.40 A. M. The wind was southwest with a velocity of 5 miles per hour. The current was flowing eastward.

	P. M.									
562	2.30	Long Island Sound, 500 feet east of Throgs Neck	40 48 20	73 47 20	1	Flood	19.0	28	5.49	95
563	2.35	Long Island Sound, 500 feet east of Throgs Neck	40 48 20	73 47 20	40	Flood	18.5	28	5.72	97
564	2.55	Long Island Sound, near Stepping Stones light	40 49 30	73 46 30	1	Flood	19.0	28	5.80	100
565	2.57	Long Island Sound, near Stepping Stones light	40 49 30	73 46 30	20	Flood	18.5	28	5.88	100
566	3.00	Long Island Sound, near Stepping Stones light	40 49 30	73 46 30	40	Flood	18.5	28	6.02	102

48—EAST RIVER COURSE FROM HELL GATE TO BATTERY. SEPTEMBER 10, 1909

Low water occurred at Governor's Island at 11.27 A. M. The wind was southeast with a velocity of 40 miles per hour.

	A. M.									
567	9.55	Hell Gate, off East 90th street	40 46 30	73 56 30	1	Ebb	19.5	32	4.05	71
568	9.57	Hell Gate, off East 90th street	40 46 30	73 56 30	40	Ebb	19.0	32	4.21	74
569	10.10	West channel, off East 59th street	40 45 25	73 57 30	1	Ebb	19.5	32	3.76	66
570	10.12	West channel, off East 59th street	40 45 25	73 57 30	20	Ebb	19.0	32	3.82	67
571	10.15	West channel, off East 59th street	40 45 25	73 57 30	40	Ebb	19.0	32	3.91	69
572	10.25	Off East 34th street, midstream	40 44 25	73 58 00	1	Ebb	19.5	32	3.76	66
573	10.28	Off East 34th street, midstream	40 44 25	73 58 00	40	Ebb	19.0	32	3.61	63
574	10.35	At Williamsburg Bridge, midstream	40 42 49	73 58 21	1	Ebb	19.5	32	3.53	62
575	10.37	At Williamsburg Bridge, midstream	40 42 49	73 58 21	20	Ebb	19.0	32	3.76	66
576	10.40	At Williamsburg Bridge, midstream	40 42 49	73 58 21	40	Ebb	19.0	32	3.91	69

TABLE XXI—Continued

48—EAST RIVER COURSE FROM HELL GATE TO BATTERY. SEPTEMBER 10, 1909—Continued

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			′ ° ″	′ ° ″						
577	10.47	At Brooklyn Bridge, midstream.......	40 42 20	73 59 48	1	Ebb	19.5	32	3.47	61
578	10.50	At Brooklyn Bridge, midstream.......	40 42 20	73 59 48	40	Ebb	19.0	32	3.61	63
579	10.55	Off Battery, midstream..............	40 41 50	74 00 50	1	Ebb	19.5	32	3.47	61
580	10.27	Off Battery, midstream..............	40 41 50	74 00 50	20	Ebb	19.0	32	3.82	67
581	11.00	Off Battery, midstream..............	40 41 50	74 00 50	40	Ebb	19.0	32	3.91	69

49—KILL VAN KULL. SEPTEMBER 11, 1909

Low water occurred at Governor's Island at 12.27 P. M. The wind was northwest with a velocity of 40 miles per hour.

	A. M.									
582	9.40	Upper bay, 500 feet off St. George ferry	40 38 55	74 04 50	1	Ebb	19.5	28	4.91	87
583	9.43	Upper bay, 500 feet off St. George ferry	40 38 55	74 04 50	40	Ebb	19.0	28	5.12	88
584	10.06	Kill van Kull, midstream, off New Brighton station..................	40 38 57	74 05 25	1	Ebb	19.5	28	4.33	76
585	10.08	Kill van Kull, midstream, off New Brighton station..................	40 38 57	74 05 25	20	Ebb	19.0	28	4.41	76
586	10.10	Kill van Kull, midstream, off New Brighton station..................	40 38 57	74 05 25	40	Ebb	19.0	28	4.52	78
587	10.25	Kill van Kull, midstream, off Sailors' Snug Harbor.....................	40 38 50	74 06 07	1	Ebb	19.5	28	3.76	66
588	10.28	Kill van Kull, midstream, off Sailors' Snug Harbor.....................	40 38 50	74 06 07	40	Ebb	19.0	28	4.21	73
589	10.45	Kill van Kull, midstream, off Port Richmond ferry..................	40 38 35	74 07 52	1	Ebb	19.5	28	4.05	71
590	10.47	Kill van Kull, midstream, off Port Richmond ferry..................	40 38 35	74 07 52	20	Ebb	19.0	28	4.41	76
591	10.50	Kill van Kull, midstream, off Port Richmond ferry..................	40 38 35	74 07 52	30	Ebb	19.0	28	4.52	78
592	11.10	Kill van Kull, west end..............	40 28 35	74 09 30	1	Ebb	19.5	28	4.05	71
593	11.12	Kill van Kull, west end..............	40 28 35	74 09 30	30	Ebb	19.0	28	4.21	73

50—LOWER BAY. SEPTEMBER 13, 1909

Low water occurred at Governor's Island at 1.55 P. M. The wind was southeast with a velocity of 5 miles per hour.

	A. M.									
594	11.00	Near Ambrose channel buoy 24.......	40 33 30	74 01 25	1	Ebb	19.5	16	4.34	78
595	11.05	Near Ambrose channel buoy 24.......	40 33 30	74 01 35	20	Ebb	19.0	16	5.59	100
596	11.10	Near Ambrose channel buoy 24.......	40 33 30	74 01 35	35	Ebb	18.5	16	5.72	102
597	11.30	In Fourteen Foot channel, near buoy A. C. 20.........................	40 32 25	74 00 45	1	Ebb	19.5	16	4.62	83
598	11.35	In Fourteen Foot channel, near buoy A. C. 20.........................	40 32 25	74 00 45	25	Ebb	18.5	16	5.72	102
	P. M.									
599	12.35	Between Ambrose and Fourteen Foot channels, near buoy A. C. 10.......	40 31 00	73 58 45	1	Ebb	19.5	16	4.62	83
600	12.40	Between Ambrose and Fourteen Foot channels, near buoy A. C. 10.......	40 31 00	73 58 45	20	Ebb	19.0	16	5.72	102
601	1.05	About 1000 feet north of buoy A. C. 4	40 30 20	73 57 00	1	Ebb	20.0	16	5.49	100
602	1.10	About 1000 feet north of buoy A. C. 4	40 30 20	73 57 00	20	Ebb	19.5	16	6.19	110
603	1.20	Near Ambrose channel buoy 4........	40 30 10	73 56 55	1	Ebb	20.0	16	5.79	105
604	1.25	Near Ambrose channel buoy 4........	40 30 10	73 56 55	35	Ebb	19.5	16	6.17	110
605	1.35	Near Ambrose channel buoy 3........	40 29 55	73 57 05	1	Ebb	20.0	16	5.49	100
606	1.37	Near Ambrose channel buoy 3........	40 29 55	73 57 05	20	Ebb	19.5	16	5.89	105
607	1.47	100 feet north of Gedney channel buoy 6...............................	40 29 30	73 57 20	1	Flood	20.0	16	5.79	105

TABLE XXI—Continued

50—LOWER BAY. SEPTEMBER 13, 1909—Continued

Sample No.	Hour P. M.	Location of Samples: Approximate	Latitude ° ′ ″	Longitude ° ′ ″	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen: C. C. per litre	Oxygen: Per cent. saturation
608	1.50	100 feet north of Gedney channel buoy 6	40 29 30	73 57 20	30	Flood	19.0	16	5.89	105
609	2.10	Between Gedney channel buoys 6 and 5	40 29 25	73 57 20	1	Flood	19.5	16	5.79	103
610	2.15	Between Gedney channel buoys 6 and 5	40 29 25	73 57 20	35	Flood	18.5	16	6.02	108
611	2.25	200 feet south of Gedney channel buoy 5	40 29 10	73 57 20	1	Flood	19.5	16	5.79	103
612	2.28	200 feet south of Gedney channel buoy 5	40 29 10	73 57 20	28	Flood	19.0	16	5.89	105
613	2.40	100 feet south of buoy C. B. 1, off Sandy Hook	40 29 15	73 58 15	1	Flood	19.5	16	6.07	108
614	2.43	100 feet south of buoy C. B. 1, off Sandy Hook	40 29 15	73 58 15	30	Flood	19.0	16	6.19	110
615	2.55	500 feet southeast of buoy C. B. 3 off Sandy Hook	40 28 50	73 59 10	1	Flood	19.5	16	6.07	108
616	3.00	500 feet southeast of buoy C. B. 3, off Sandy Hook	40 28 50	73 59 10	35	Flood	19.0	16	6.19	110
617	3.30	1000 feet northeast of buoy N. 8	40 28 55	74 01 20	1	Flood	19.5	16	5.49	98
618	3.35	1000 feet northeast of buoy N. 8	40 28 55	74 01 20	15	Flood	18.5	16	5.89	105
619	3.55	500 feet southwest of buoy C. S. 1, near Swash channel	40 29 35	74 00 30	1	Flood	19.5	16	5.59	100
620	4.00	500 feet southwest of buoy C. S. 1, near Swash channel	40 29 35	74 00 30	35	Flood	18.5	16	6.02	108

51—LOWER BAY. SEPTEMBER 14, 1909

Low water occurred at Governor's Island at 2.40 P. M. The wind was southeast with a velocity of 10 miles per hour.

Sample No.	Hour	Location of Samples: Approximate	Latitude ° ′ ″	Longitude ° ′ ″	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen: C. C. per litre	Oxygen: Per cent. saturation
	A. M.									
621	10.30	Main Ship channel, 200 feet east of West Bank light	40 32 20	74 02 30	1	Ebb	19.5	16	4.91	88
622	10.35	Main Ship channel, 200 feet east of West Bank light	40 32 20	74 02 30	35	Ebb	18.5	16	5.29	94
623	10.55	Swash channel, near Main Ship channel	40 31 25	74 02 20	1	Ebb	19.5	16	4.91	88
624	11.00	Swash channel, near Main Ship channel	40 31 25	74 02 20	30	Ebb	19.0	16	5.29	94
625	11.25	Swash channel, 300 feet northeast of buoy C. S. 3	40 30 50	74 01 45	1	Ebb	19.5	16	5.20	93
626	11.30	Swash channel, 300 feet northeast of buoy C. S. 3	40 30 50	74 01 45	20	Ebb	19.0	16	5.59	100
627	11.47	Swash channel, 500 feet south of Romer Shoals light	40 30 45	74 00 45	1	Ebb	19.5	16	4.91	88
628	11.50	Swash channel, 500 feet south of Romer Shoals light	40 30 45	74 00 45	30	Ebb	19.0	16	5.00	89
	P. M.									
629	1.00	Swash channel, 500 feet south of buoy N. S. 4	40 30 00	73 59 45	1	Ebb	19.5	16	5.49	98
630	1.05	Swash channel, 500 feet south of buoy N. S. 4	40 30 00	73 59 45	30	Ebb	19.0	16	5.59	100
631	1.20	Swash channel, 500 feet north of buoy C. S. 1	40 29 45	74 00 30	1	Ebb	19.5	16	5.20	93
632	1.25	Swash channel, 500 feet north of buoy C. S. 1	40 29 45	74 00 30	25	Ebb	19.0	16	5.29	94
633	1.45	Romer Shoals, 500 feet northwest of buoy N. S. 2	40 29 50	73 59 20	1	Ebb	19.5	16	5.29	94
634	1.50	Romer Shoals, 500 feet northwest of buoy N. S. 2	40 29 50	73 59 20	25	Ebb	19.0	16	5.42	97
635	2.05	500 feet southeast of buoy A. C. 9, Ambrose channel	40 30 45	73 58 45	1	Ebb	19.5	16	5.20	93
636	2.10	500 feet southeast of buoy A. C. 9, Ambrose channel	40 30 45	73 58 45	20	Ebb	19.0	16	5.29	94

TABLE XXI—Continued

51—LOWER BAY. SEPTEMBER 14, 1909—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
637	2.15	500 feet northwest of buoy A. C. 10, Ambrose channel	40 31 00	73 58 55	1	Ebb	19.5	16	5.00	89
638	2.20	500 feet northwest of buoy A. C. 10, Ambrose channel	40 31 00	73 58 55	25	Ebb	19.0	16	5.12	92
639	2.45	⅓ of distance between buoy A. C. 8 and Manhattan Beach	40 32 05	73 57 40	1	Ebb	19.5	16	5.12	92
640	2.50	⅓ of distance between buoy A. C. 8 and Manhattan Beach	40 32 05	73 57 40	20	Ebb	19.0	16	5.29	94
641	3.10	⅔ of distance between buoy A. C. 8 and Manhattan Beach	40 33 05	73 57 25	1	Ebb	19.5	16	4.91	88
642	3.15	⅔ of distance between buoy A. C. 8 and Manhattan Beach	40 33 05	73 57 25	22	Ebb	19.0	16	5.12	92

52—PASSAIC RIVER, NEWARK BAY AND KILL VAN KULL. SEPTEMBER 15, 1909

Low water occurred at Governor's Island at 2.55 P. M. The wind was southeast, with a velocity of 20 miles per hour.

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
	P. M.									
643	12.40	Passaic river, near foot of N. J. R.R. avenue, Newark	40 44 49	74 09 55	1	Ebb	22.0	52	0.00	0
644	12.45	Passaic river, near foot of N. J. R.R. avenue, Newark	40 44 49	74 09 55	10	Ebb	21.5	52	0.00	0
645	1.05	Passaic river, near P. R.R. freight bridge, below Newark	40 44 10	74 09 45	1	Ebb	22.0	52	1.16	20
646	1.08	Passaic river, near P. R.R. freight bridge, below Newark	40 44 10	74 09 45	10	Ebb	21.5	52	1.18	20
647	1.25	Passaic river, near mouth	40 43 15	74 07 20	1	Ebb	21.0	52	2.60	45
648	1.30	Passaic river, near mouth	40 43 15	74 07 20	10	Ebb	20.5	52	2.71	47
649	1.45	Newark bay, near Lehigh Valley R.R. bridge	40 41 56	74 07 15	1	Ebb	20.0	32	3.76	66
650	1.50	Newark bay, near Lehigh Valley R.R. bridge	40 41 56	74 07 15	20	Ebb	19.5	32	3.91	69
651	2.05	Newark bay, near bell buoy off Centreville	40 40 15	74 08 10	1	Ebb	20.0	32	4.04	71
652	2.08	Newark bay, near bell buoy off Centreville	40 40 15	74 08 10	20	Ebb	20.0	32	4.22	74
653	2.15	Newark bay, near C. R.R. of N. J. drawbridge	40 39 17	74 08 46	1	Ebb	20.0	32	4.04	71
654	2.18	Newark bay, near C. R.R. of N. J. drawbridge	40 39 17	74 08 46	20	Ebb	19.0	32	4.22	73
655	2.25	Kill van Kull, west end	40 38 35	74 08 45	1	Ebb	20.0	28	4.34	76
656	2.27	Kill van Kull, west end	40 38 35	74 08 45	20	Ebb	19.5	28	4.41	78
657	2.30	Kill van Kull, west end	40 38 35	74 08 45	35	Ebb	19.0	28	4.52	78
658	2.43	Kill van Kull, off Sailors' Snug Harbor	40 38 50	74 06 25	1	Ebb	20.0	28	4.04	71
659	2.45	Kill van Kull, off Sailors' Snug Harbor	40 38 50	74 06 25	30	Ebb	19.5	28	4.22	74
660	2.55	Kill van Kull, off Constable Hook	40 39 05	74 05 15	1	Ebb	20.0	28	4.34	76
661	2.57	Kill van Kull, off Constable Hook	40 39 05	74 05 15	20	Ebb	19.5	28	4.41	78
662	3.00	Kill van Kull, off Constable Hook	40 39 05	74 05 15	40	Ebb	19.0	28	4.82	83

53—ARTHUR KILL. SEPTEMBER 16, 1910

Low water occurred at Governor's Island at 3.27 P. M. The wind was southeast with a velocity of 5 miles per hour.

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
	A. M.									
663	11.55	Rahway river, ½ mile from mouth	40 35 55	74 12 45	1	Ebb	20.0	64	3.47	58
664	11.57	Rahway river, ½ mile from mouth	40 35 55	74 12 45	8	Ebb	19.5	64	3.61	60
	P. M.									
665	12.25	Arthur Kills, opposite mouth of Rahway river	40 35 35	74 12 15	1	Ebb	20.0	28	3.76	66

TABLE XXI—Continued

53—ARTHUR KILL. SEPTEMBER 16, 1910—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
666	12.30	Arthur Kills, opposite mouth of Rahway river	40 35 35	74 12 15	10	Ebb	19.5	28	3.92	69
667	1.05	Arthur Kills, off Fresh Kills	40 34 45	74 12 35	1	Ebb	20.0	28	4.04	71
668	1.10	Arthur Kills, off Fresh Kills	40 34 45	74 12 35	15	Ebb	19.5	28	4.34	76
669	1.20	Arthur Kills, near buoy S. A., off Smoking Point	40 33 30	74 13 40	1	Ebb	19.0	28	4.04	70
670	1.25	Arthur Kills, near buoy S. A., off Smoking Point	40 33 30	74 13 40	25	Ebb	18.5	28	4.52	77
671	2.00	Arthur Kills, near buoy S. 6, north of Rahway river	40 35 45	74 12 05	1	Ebb	19.5	28	4.41	78
672	2.05	Arthur Kills, near buoy S. 6, north of Rahway river	40 35 45	74 12 05	12	Ebb	19.5	28	4.52	79
673	2.35	Arthur Kills, 1000 feet west of Elizabethport drawbridge	40 38 10	74 11 55	1	Ebb	19.5	28	3.47	60
674	2.38	Arthur Kills, 1000 feet west of Elizabethport drawbridge	40 38 10	74 11 55	12	Ebb	19.0	28	4.22	73
675	2.50	Arthur Kills, 1000 feet east of Elizabethport drawbridge	40 38 20	74 11 45	1	Ebb	19.5	28	3.76	66
676	2.55	Arthur Kills, 1000 feet east of Elizabethport drawbridge	40 38 20	74 11 45	15	Ebb	19.0	28	4.34	75
677	3.05	Arthur Kills, near buoy S. 4, at east end	40 38 45	74 10 45	1	Ebb	19.5	28	4.41	78
678	3.07	Arthur Kills, near buoy S. 4, at east end	40 38 45	74 10 45	15	Ebb	19.0	28	4.52	78
679	3.17	Midway between Shooters' Island and Mariners' Harbor	40 28 35	74 09 30	1	Ebb	19.5	28	4.41	78
680	3.20	Midway between Shooters' Island and Mariners' Harbor	40 28 35	74 09 30	30	Ebb	19.0	28	4.52	78
681	3.35	Kill van Kull, west end	40 38 35	74 08 45	1	Ebb	19.5	28	4.34	76
682	3.40	Kill van Kull, west end	40 38 35	74 08 45	35	Ebb	19.0	28	4.52	78

54—JAMAICA BAY. SEPTEMBER 17, 1909

Low water occurred at Governors Island at 4.27 P. M. The wind was northwest with a velocity of 5 miles per hour.

	A. M.									
683	10.40	Jamaica bay, near Dead Horse creek	40 34 35	73 54 25	1	Ebb	19.5	20	4.34	78
684	10.45	Jamaica Bay, near Dead Horse Creek	40 34 35	73 54 25	15	Ebb	19.0	20	4.82	86
685	11.00	Jamaica bay, 200 feet off Barren Island	40 34 40	73 53 00	1	Ebb	19.5	20	4.34	78
686	11.05	Jamaica bay, 200 feet off Barren Island	40 34 40	73 53 00	20	Ebb	19.0	20	4.52	81
687	11.25	Just south of Ruffle Bar	40 35 40	73 51 35	1	Ebb	19.5	20	4.62	83
688	11.30	Just south of Ruffle Bar	40 35 40	73 51 35	15	Ebb	19.0	20	5.12	92
689	11.50	About 1 mile off Canarsie breakwater	40 36 45	73 52 35	1	Ebb	19.5	20	4.04	72
690	11.55	About 1 mile off Canarsie breakwater	40 36 45	73 52 35	9	Ebb	19.0	20	4.52	81
	P. M.									
691	12.10	200 feet off Canarsie light	40 37 20	73 52 45	1	Ebb	19.5	20	3.76	67
692	12.12	200 feet off Canarsie light	40 37 20	73 52 45	10	Ebb	19.5	20	3.91	70
693	1.05	200 feet off Canarsie landing	40 37 40	73 53 10	1	Ebb	19.5	20	3.47	62
694	1.08	200 feet off Canarsie landing	40 37 40	73 53 10	8	Ebb	19.5	20	3.61	65
695	2.00	1000 feet off mouth of Fresh creek	40 38 20	73 52 15	1	Ebb	19.5	20	1.44	26
696	2.15	1000 feet off mouth of Second creek	40 38 30	73 52 15	1	Ebb	19.5	20	0.59	11
697	2.30	½ mile north of mouth of Second creek	40 38 45	73 51 35	1	Ebb	19.5	20	4.91	88
698	3.00	1000 feet off shore of Sand bay	40 38 05	73 52 40	1	Ebb	19.5	20	3.18	57

TABLE XXI—Continued

55—HUDSON RIVER. SEPTEMBER 18, 1909

High water occurred at Governor's Island at 10.36 A. M. The wind was southwest with a velocity of 10 miles per hour.

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
699	10.05	500 feet off C. R.R. of N. J. ferry, Communipaw	40 42 25	74 02 00	1	Flood	19.5	28	4.34	76
700	10.08	500 feet off C. R.R. of N. J. ferry, Communipaw	40 42 25	74 02 00	40	Flood	18.5	28	4.52	77
701	10.15	500 feet off P. R.R. ferry, Jersey City	40 43 00	74 01 55	1	Flood	19.5	28	4.04	71
702	10.17	500 feet off P. R.R. ferry, Jersey City	40 43 00	74 01 55	20	Flood	19.0	28	4.12	71
703	10.19	500 feet off P. R.R. ferry, Jersey City	40 43 00	74 01 55	40	Flood	18.5	28	4.22	72
704	10.35	500 feet off Lackawanna ferry, Hoboken	40 43 40	74 01 50	1	Flood	19.5	28	3.76	66
705	10.38	500 feet off Lackawanna ferry, Hoboken	40 43 40	74 01 50	40	Flood	18.5	28	3.91	66
706	10.50	500 feet off Stevens' Point, Hoboken	40 44 40	74 01 20	1	Flood	19.5	28	4.04	71
707	10.52	500 feet off Stevens' Point, Hoboken	40 44 40	74 01 20	20	Flood	19.0	28	4.22	73
708	10.55	500 feet off Stevens' Point, Hoboken	40 44 40	74 01 20	40	Flood	18.5	28	4.41	75
709	11.25	500 feet off West Shore ferry, Weehawken	40 46 45	74 00 20	1	Flood	19.5	28	4.12	72
710	11.28	500 feet off West Shore ferry, Weehawken	40 46 45	74 00 20	40	Flood	18.5	28	4.34	74

56—LOWER BAY. SEPTEMBER 20, 1909

Low water occurred at Governor's Island at 5.27 P. M. The wind was southeast with a velocity of 40 miles per hour.

	A. M.									
711	11.55	500 feet southwest of West Bank light	40 32 10	74 02 40	1	Flood	19.0	8	5.20	95
712	11.58	500 feet southwest of West Bank light	40 32 10	74 02 40	20	Flood	18.5	8	5.72	102
	P. M.									
713	12.20	About 1 mile from West Bank light, on line with Port Monmouth	40 31 25	74 03 00	1	Flood	19.0	8	5.20	95
714	12.22	About 1 mile from West Bank light, on line with Port Monmouth	40 31 25	74 03 00	20	Flood	18.5	8	5.72	102
715	1.00	Near white buoy S. on same line	40 30 20	74 03 15	1	Flood	19.0	8	5.20	95
716	1.05	Near white buoy S. on same line	40 30 20	73 03 15	20	Flood	18.5	8	5.42	97
717	1.20	Farther south on same line	40 29 35	74 03 25	1	Flood	19.0	8	5.00	91
718	1.25	Farther south on same line	40 29 35	74 03 25	25	Flood	18.5	8	5.42	97
719	1.40	Farther south on same line near buoy C. C. 1	40 28 35	74 03 15	1	Flood	19.0	8	5.20	95
720	1.43	Farther south on same line near buoy C. C. 1	40 28 35	74 03 15	25	Flood	18.5	8	5.42	97
721	2.00	Farther south on same line	40 27 40	74 02 40	1	Flood	19.0	8	4.91	90
722	2.03	Farther south on same line	40 27 40	74 02 40	20	Flood	18.5	8	5.12	92
723	2.20	About 1 mile off Atlantic Highlands	40 26 25	74 03 15	1	Flood	18.5	8	4.91	88
724	2.23	About 1 mile off Atlantic Highlands	40 26 25	74 03 15	20	Flood	18.5	8	5.12	92
725	2.40	About ½ mile off Atlantic Highlands	40 25 50	74 03 25	1	Ebb	19.[illegible]	8	4.91	90
726	2.43	About ½ mile off Atlantic Highlands	40 25 50	74 03 25	18	Ebb	18.5	8	5.00	89
727	3.40	2000 feet west of buoy S. 1 W. off Point Comfort	40 29 00	74 07 50	1	Ebb	19.0	8	5.79	104
728	3.42	2000 feet west of buoy S. 1 W. off Point Comfort	40 29 00	74 07 50	12	Ebb	18.5	8	6.20	110
729	4.00	Nearer Great Kills	40 29 50	74 07 40	1	Ebb	19.0	8	6.07	109
730	4.02	Nearer Great Kills	40 29 50	74 07 40	25	Ebb	18.5	8	6.02	108
731	4.20	1½ miles south of Great Kills	40 30 35	74 07 40	1	Ebb	19.0	8	5.79	104
732	4.23	1½ miles south of Great Kills	40 30 35	74 07 40	15	Ebb	18.5	8	6.02	108
733	4.32	1 mile south of Great Kills	40 31 10	74 07 45	1	Ebb	19.0	8	5.79	104
734	4.35	1 mile south of Great Kills	40 31 10	74 07 45	10	Ebb	18.5	8	6.02	108

TABLE XXI—Continued

57—RARITAN BAY. SEPTEMBER 21, 1909

Low water occurred at Governor's Island at 6.52 P. M. The wind was southwest with a velocity of 5 miles per hour.

Sample No.	Hour A. M.	Location of Samples: Approximate	Latitude ° ′ ″	Longitude ° ′ ″	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen: C. C. per litre	Oxygen: Per cent. saturation
735	11.45	Raritan bay, 1000 feet east of buoy S. E., off Seguine Point	40 30 30	74 01 05	1	Flood	19.0	8	6.07	110
736	11.47	Raritan bay, 1000 feet east of buoy S. E., off Seguine Point	40 30 30	74 01 05	20	Flood	18.5	8	6.20	110
737	P. M. 12.05	Near buoy S. 3 in Seguine channel	40 30 30	74 11 25	1	Flood	19.0	8	6.07	110
738	12.07	Near buoy S. 3 in Seguine channel	40 30 30	74 11 25	25	Flood	18.5	8	6.20	110
739	12.20	1000 feet southeast of Princess bay light	40 30 20	74 12 35	1	Flood	19.0	8	6.07	110
740	12.22	1000 feet southeast of Princess bay light	40 30 20	74 12 35	20	Flood	18.5	8	.17	110
741	12.30	Near red buoy S. 6	40 29 45	74 13 35	1	Flood	19.0	8	6.00	109
742	12.32	Near red buoy S. 6	40 29 45	74 13 35	25	Flood	18.5	8	6.19	110
743	12.45	Near red buoy S. 8	40 29 05	74 14 20	1	Flood	19.0	8	6.00	109
744	12.47	Near red buoy S. 8	40 29 05	74 14 20	25	Flood	18.5	8	6.19	110
745	1.00	500 feet north of Great Beds light	40 29 15	74 15 15	1	Flood	19.0	8	5.79	105
746	1.05	500 feet north of Great Beds light	40 29 15	74 15 15	16	Flood	18.5	8	6.03	108

58—ARTHUR KILL. SEPTEMBER 21, 1909

Low water occurred at Governor's Island at 6.52 P. M. The wind was southeast with a velocity of 5 miles per hour.

Sample No.	Hour	Location of Samples: Approximate	Latitude ° ′ ″	Longitude ° ′ ″	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen: C. C. per litre	Oxygen: Per cent. saturation
747	P. M. 1.20	Lower end of Kills, 200 feet west of buoy S.	40 30 10	74 15 40	1	Flood	19.0	8	5.79	105
748	1.25	Lower end of Kills, 200 feet west of buoy S.	40 30 10	74 15 40	30	Flood	18.5	8	6.02	108
749	1.40	Off Tottenville, 200 feet west of buoy S. 2	40 30 55	74 15 15	1	Flood	19.0	8	5.49	100
750	1.45	Off Tottenville, 200 feet west of buoy S. 2	40 30 55	74 15 15	45	Flood	18.0	8	5.72	102
751	2.15	Off Smoking Point, 200 feet east of buoy S. A.	40 33 30	74 13 50	1	Flood	19.0	8	5.49	100
752	2.17	Off Smoking Point, 200 feet east of buoy S. A.	40 33 30	74 13 50	30	Flood	18.5	8	5.72	102
753	2.35	Off Fresh Kills	40 34 20	74 12 40	1	Flood	19.0	8	5.20	95
754	2.40	Off Fresh Kills	40 34 20	74 12 40	28	Flood	18.5	8	5.42	97

59—KILL VAN KULL, UPPER BAY AND EAST RIVER. SEPTEMBER 23, 1909

High water occurred at Governor's Island at 2.20 P. M. The wind was southwest with a velocity of 10 miles per hour.

Sample No.	Hour	Location of Samples: Approximate	Latitude ° ′ ″	Longitude ° ′ ″	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen: C. C. per litre	Oxygen: Per cent. saturation
755	A. M. 11.10	West end of Kill van Kull, near buoy S. 2	40 38 30	74 08 30	1	Flood	18.5	20	3.76	66
756	11.12	West end of Kill van Kull, near buoy S. 2	40 38 30	74 08 30	40	Flood	18.0	20	4.52	78
757	11.30	Kill van Kull off Livingston station	40 38 45	74 06 50	1	Flood	18.5	20	4.34	76
758	11.32	Kill van Kull, off Livingston station	40 38 45	74 06 50	20	Flood	18.0	20	4.41	76
759	11.35	Kill van Kull, off Livingston station	40 38 45	74 06 50	40	Flood	18.0	20	4.82	83
760	P. M. 12.20	East end of Kill van Kull, off Constable Hook	40 39 05	74 05 15	1	Flood	18.5	20	4.62	81
761	12.25	East end of Kill van Kull, off Constable Hook	40 39 05	74 05 15	40	Flood	18.0	20	4.82	83
762	12.50	Upper bay, near Robbin's Reef bell buoy	40 39 15	74 03 50	1	Flood	18.5	20	4.91	86

TABLE XXI—Continued

59—KILL VAN KULL, UPPER BAY AND EAST RIVER. SEPTEMBER 23, 1909—Continued

Sample No.	Hour P. M.	Location of Samples: Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen: C. C. per litre	Oxygen: Per cent. saturation
			° ′ ″	° ′ ″						
763	12.52	Upper bay, near Robbin's Reef bell buoy	40 39 15	74 03 50	20	Flood	18.0	20	5.00	86
764	12.55	Upper bay, near Robbin's Reef bell buoy	40 39 15	74 03 50	40	Flood	18.0	20	5.12	88
765	1.05	Upper bay, near buoy G. 2	40 40 10	74 03 12	1	Flood	18.5	20	4.77	84
766	1.07	Upper bay, near buoy G. 2	40 40 10	74 03 12	40	Flood	18.0	20	5.00	86
767	1.15	Upper bay, near buoy S. 2, off Liberty Island	40 41 05	74 02 40	1	Flood	18.5	20	4.34	76
768	1.17	Upper bay, near buoy S. 2, off Liberty Island	40 41 05	74 02 40	20	Flood	18.0	20	4.41	76
769	1.18	Upper bay, near buoy S. 2, off Liberty Island	40 41 05	74 02 40	40	Flood	18.0	20	4.52	78
770	1.25	East river, between Governor's Island and Battery	40 41 50	74 01 00	1	Flood	18.5	20	4.19	74
771	1.27	East river, between Governor's Island and Battery	40 41 50	74 01 00	40	Flood	18.0	20	4.27	74
772	1.35	East river, midstream, at Brooklyn Bridge	40 42 20	73 59 48	1	Flood	18.5	20	4.04	71
773	1.37	East river, midstream, at Brooklyn bridge	40 42 20	73 59 48	20	Flood	18.0	20	4.12	71
774	1.40	East river, midstream, at Brooklyn Bridge	40 42 20	73 59 48	40	Flood	18.0	20	4.22	73
775	1.52	East river, midstream, at Manhattan Bridge	40 42 25	73 59 25	1	Flood	18.5	20	3.76	66
776	1.54	East river, midstream, at Manhattan Bridge	40 42 25	73 59 25	40	Flood	18.0	20	3.92	68

60—UPPER BAY. SEPTEMBER 30, 1909.

Low water occurred at Governor's Island at 3.19 P. M. The wind was northwest with a velocity of 30 miles per hour.

	A. M.									
777	10.37	Upper bay, 200 feet off Battery	40 42 10	74 01 10	1	Ebb	18.5	28	4.62	78
778	10.38	Upper bay, 200 feet off Battery	40 42 10	74 01 10	40	Ebb	18.0	28	4.82	82
779	10.53	Upper bay, 200 feet west of Governor's Island	40 41 35	74 01 15	1	Ebb	18.5	28	4.62	78
780	10.54	Upper bay, 200 feet west of Governor's Island	40 41 35	74 01 15	20	Ebb	18.0	28	4.71	80
781	10.56	Upper bay, 200 feet west of Governor's Island	40 41 35	74 01 15	40	Ebb	18.0	28	5.12	87
782	11.55	Upper bay, near buoy G. 2	40 40 10	74 03 12	1	Ebb	18.5	28	4.91	84
783	11.57	Upper bay, near buoy G. 2	40 40 10	74 03 12	40	Ebb	18.0	28	5.12	87
	P. M.									
784	12.07	Upper bay, 1000 feet west of Robbins Reef light	40 39 25	74 03 45	1	Ebb	18.5	28	4.91	84
785	12.10	Upper bay, 1000 feet west of Robbins Reef light	40 39 25	74 03 45	20	Ebb	18.0	28	5.12	87

61—KILL VAN KULL. SEPTEMBER 30, 1909

Low water occurred at Governor's Island at 3.19 P. M. The wind was northwest with a velocity of 30 miles per hour.

	P. M.									
786	12.20	Kill van Kull, east end	40 39 05	74 05 15	1	Ebb	18.5	28	4.62	78
787	12.22	Kill van Kull, east end	40 39 05	74 05 15	20	Ebb	18.0	28	4.71	80
788	12.25	Kill van Kull, east end	40 39 05	74 05 15	40	Ebb	18.0	28	5.12	87
789	12.35	Kill van Kull, off Sailor's Snug Harbor	40 38 50	74 06 07	1	Ebb	18.5	28	4.34	74
790	12.38	Kill van Kull, off Sailor's Snug Harbor	40 38 50	74 06 07	40	Ebb	18.0	28	4.52	77

TABLE XXI—Continued

61—KILL VAN KULL. SEPTEMBER 30, 1909—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
791	1.05	Kill van Kull, off Port Richmond.....	40 38 35	74 07 52	1	Ebb	18.5	28	4.04	69
792	1.07	Kill van Kull, off Port Richmond.....	40 38 35	74 07 52	20	Ebb	18.0	28	4.12	70
793	1.09	Kill van Kull, off Port Richmond.....	40 38 35	74 07 52	40	Ebb	18.0	28	4.22	72
794	2.40	Kill van Kull, west end..............	40 38 30	74 08 30	1	Ebb	18.5	28	4.04	69
795	2.43	Kill van Kull, west end..............	40 38 30	74 08 30	40	Ebb	18.0	28	4.22	72

62—EAST RIVER. OCTOBER 1, 1919

High water occurred at Governor's Island at 9.23 A. M. The wind was northwest with a velocity of 40 miles per hour.

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
	A. M.									
796	9.50	500 feet off Pier 32, Brooklyn.........	40 41 10	74 00 30	1	Flood	18.0	28	4.62	78
797	9.52	500 feet off Pier 32, Brooklyn.........	40 41 10	74 00 30	40	Flood	18.0	28	4.82	82
798	10.00	At Brooklyn Bridge, 500 feet off Brooklyn shore.........................	40 42 15	73 59 45	1	Flood	18.0	28	4.48	76
799	10.02	At Brooklyn Bridge, 500 feet off Brooklyn shore.........................	40 42 15	73 59 45	20	Flood	18.0	28	4.57	77
800	10.04	At Brooklyn Bridge, 500 feet off Brooklyn shore.........................	40 42 15	73 59 45	40	Flood	18.0	28	4.82	82
801	10.16	At Williamsburg Bridge, 500 feet off Brooklyn shore...................	40 42 45	73 59 10	1	Flood	18.0	28	4.34	74
802	10.18	At Williamsburg Bridge, 500 feet off Brooklyn shore...................	40 42 45	73 58 10	40	Flood	18.0	28	4.52	77
803	10.30	Opposite East 34th street, 500 feet off Brooklyn shore...................	40 44 20	73 57 45	1	Flood	18.0	28	3.76	64
804	10.31	Opposite East 34th street, 500 feet off Brooklyn shore...................	40 44 20	73 57 45	20	Flood	18.0	28	4.13	70
805	10.33	Opposite East 34th street, 500 feet off Brooklyn shore...................	40 44 20	73 57 45	40	Flood	18.0	28	4.22	72
806	10.50	At Queensboro Bridge, East channel..	40 45 20	73 57 10	1	Flood	18.0	28	4.34	74
807	10.52	At Queensboro Bridge, East channel..	40 45 20	73 57 10	40	Flood	18.0	28	4.52	77
808	11.05	At Hell Gate.........................	40 46 50	73 56 00	1	Flood	18.0	28	4.34	74
809	11.06	At Hell Gate.........................	40 46 50	73 56 00	20	Flood	18.0	28	4.41	75
810	11.08	At Hell Gate.........................	40 46 50	73 56 00	40	Flood	18.0	28	4.82	82

63—LONG ISLAND SOUND. OCTOBER 1, 1909

Low water occurred at Governor's Island at 4.07 P. M. The wind was northwest with a velocity of 40 miles per hour. The current was flowing westward.

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
	P. M.									
811	1.20	Long Island Sound, near Throg's Neck	40 48 20	73 47 20	1	Ebb	18.0	28	5.79	98
812	1.22	Long Island Sound, near Throg's Neck	40 48 20	73 47 20	25	Ebb	18.0	28	5.89	100
813	1.24	Long Island Sound, near Throg's Neck	40 48 20	73 47 20	50	Ebb	18.0	28	6.02	102

64—EAST RIVER AND HARLEM RIVER. OCTOBER 1, 1909

Low water occurred at Governor's Island at 4.07 P. M. The wind was northwest with a velocity of 40 miles per hour.

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
	P. M.									
814	1.55	East river, between North and South Brothers Island...................	40 47 55	73 53 55	1	Ebb	18.0	28	4.91	83
815	1.57	East river, between North and South Brothers Island...................	40 47 55	73 53 55	40	Ebb	18.0	28	5.12	87
816	2.13	Midstream, off East 116th street, Harlem river........................	40 47 35	73 55 50	1	Ebb	18.5	28	3.76	64
817	2.15	Midstream, off East 116th street, Harlem river........................	40 47 35	73 55 50	20	Ebb	18.5	28	3.92	66

TABLE XXI—Continued

64—EAST RIVER AND HARLEM RIVER. OCTOBER 1, 1909—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
818	2.25	Midstream, off East 110th street, Harlem river	40 47 20	73 56 05	1	Ebb	18.5	28	3.76	64
819	2.27	Midstream, off East 110th street, Harlem river	40 47 20	73 56 05	20	Ebb	18.5	28	3.92	66
820	2.35	Hell Gate, off East 90th street, East river	40 46 40	73 56 20	1	Ebb	18.0	28	4.62	78
821	2.36	Hell Gate, off East 90th street, East river	40 46 40	73 56 20	20	Ebb	18.0	28	4.71	80
822	2.38	Hell Gate, off East 90th street, East river	40 46 40	73 56 20	40	Ebb	18.0	28	4.82	82
823	2.47	At Queensboro Bridge, West channel, East river	40 45 25	73 57 30	1	Ebb	18.0	28	4.34	74
824	2.50	At Queensboro Bridge, West channel, East river	40 45 25	73 57 30	40	Ebb	18.0	28	4.82	82
825	3.08	1000 feet off mouth of Newtown creek, East river	40 44 10	73 57 55	1	Ebb	18.5	28	3.18	54
826	3.10	1000 feet off mouth of Newtown creek, East river	40 44 10	73 57 55	30	Ebb	18.0	28	3.61	61
827	3.28	1000 feet off Wallabout bay, East river	40 42 25	73 58 30	1	Ebb	18.5	28	3.47	59
828	3.30	1000 feet off Wallabout bay, East river	40 42 25	73 58 30	20	Ebb	18.0	28	3.82	65
829	3.32	1000 feet off Wallabout bay, East river	40 42 25	73 58 30	40	Ebb	18.0	28	4.22	72

65—EAST RIVER. OCTOBER 2, 1909

High water occurred at Governor's Island at 10.19 A. M. The wind was west, with a velocity of 20 miles per hour.

	A. M.									
830	9.20	500 feet off Pier 4, Manhattan	40 42 00	74 00 40	1	Flood	17.0	28	4.62	78
831	9.21	500 feet off Pier 4, Manhattan	40 42 00	74 00 40	20	Flood	17.0	28	4.71	79
832	9.23	500 feet off Pier 4, Manhattan	40 42 00	74 00 40	40	Flood	17.0	28	4.82	81
833	9.35	At Brooklyn Bridge, 500 feet off Manhattan shore	40 42 25	73 59 55	1	Flood	17.0	28	4.34	73
834	9.37	At Brooklyn Bridge, 500 feet off Manhattan shore	40 42 25	73 59 55	40	Flood	17.0	28	4.52	76
835	9.50	At Williamsburg Bridge, 500 feet off Manhattan shore	40 42 50	73 58 30	1	Flood	17.0	28	4.04	68
836	9.52	At Williamsburg Bridge, 500 feet off Manhattan shore	40 42 50	73 58 30	20	Flood	17.0	28	4.12	69
837	9.55	At Williamsburg Bridge, 500 feet off Manhattan shore	40 42 50	73 58 30	40	Flood	17.0	28	4.22	71
838	10.15	Opposite East 34th street, 500 feet off shore	40 44 30	73 58 15	1	Flood	17.0	28	3.90	66
839	10.18	Opposite East 34th street, 500 feet off shore	40 44 30	73 58 15	40	Flood	17.0	28	4.00	67
840	10.30	At Queensboro Bridge, West channel	40 45 25	73 57 30	1	Flood	17.0	28	4.04	68
841	10.31	At Queensboro Bridge, West channel	40 45 25	73 57 30	20	Flood	17.0	28	4.12	69
842	10.33	At Queensboro Bridge, West channel	40 45 25	73 57 30	40	Flood	17.0	28	4.22	71
843	10.40	Hell Gate, off East 90th street	40 46 30	73 56 20	1	Flood	17.0	28	4.04	68
844	10.41	Hell Gate, off East 90th street	40 46 30	73 56 20	20	Flood	17.0	28	4.12	69
845	10.43	Hell Gate, off East 90th street	40 46 30	73 56 20	40	Flood	17.0	28	4.52	76

TABLE XXI—Continued

66—HUDSON RIVER CROSS-SECTIONS. OCTOBER 5, 1909

High water occurred at Governor's Island at 12.41 P. M. The wind was northwest with a velocity of 10 miles per hour.

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
846	10.55	⅕ way across from foot of West 42d street	40 45 50	74 00 20	1	Flood	17.0	52	4.91	78
847	10.56	⅕ way across from foot of West 42d street	40 45 50	74 00 20	20	Flood	17.0	52	5.00	79
848	10.57	⅕ way across from foot of West 42d street	40 45 50	74 00 20	40	Flood	17.0	52	5.12	81
849	11.05	⅖ way across from foot of West 42d street	40 45 55	74 00 30	1	Flood	17.0	52	5.20	83
850	11.07	⅖ way across from foot of West 42d street	40 45 55	74 00 30	20	Flood	17.0	52	5.29	84
851	11.09	⅖ way across from foot of West 42d street	40 45 55	74 00 30	40	Flood	17.0	52	5.42	86
852	11.15	¾ way across from foot of West 42d street	40 46 00	74 00 50	1	Flood	17.0	52	5.49	87
853	11.17	¾ way across from foot of West 42d street	40 46 00	74 00 50	20	Flood	17.0	52	5.59	89
854	11.19	¾ way across from foot of West 42d street	40 46 00	74 00 50	40	Flood	17.0	52	5.72	91
855	P. M. 12.15	⅕ way across from foot of West 137th street	40 49 30	73 57 35	1	Flood	17.0	52	5.20	83
856	12.16	⅕ way across from foot of West 137th street	40 49 30	73 57 35	20	Flood	17.0	52	5.29	84
857	12.18	⅕ way across from foot of West 137th street	40 49 30	73 57 35	40	Flood	17.0	52	5.42	86
858	12.28	⅖ way across from foot of West 137th street	40 49 35	73 57 50	1	Flood	17.0	52	5.20	83
859	12.29	⅖ way across from foot of West 137th street	40 49 35	73 57 50	20	Flood	17.0	52	5.29	84
860	12.30	⅖ way across from foot of West 137th street	40 49 35	73 57 50	40	Flood	17.0	52	5.42	86
861	12.40	¾ way across from foot of West 137th street	40 49 40	73 58 05	1	Flood	17.0	52	5.49	87
862	12.41	¾ way across from foot of West 137th street	40 49 40	73 58 05	20	Flood	17.0	52	5.59	89
863	12.43	¾ way across from foot of West 137th street	40 49 40	73 58 05	25	Flood	17.0	52	5.72	91
864	1.20	500 feet off Inwood	40 52 20	73 55 55	1	Flood	17.0	52	5.49	87
865	1.21	500 feet off Inwood	40 52 20	73 55 55	20	Flood	17.0	52	5.59	89
866	1.23	500 feet off Inwood	40 52 20	73 55 55	40	Flood	17.0	52	5.72	91
867	1.33	⅓ way across from Inwood	40 52 25	73 56 05	1	Flood	17.0	52	5.49	87
868	1.34	⅓ way across from Inwood	40 52 25	73 56 05	20	Flood	17.0	52	5.89	94
869	1.36	⅓ way across from Inwood	40 52 25	73 56 05	40	Flood	17.0	52	6.02	96
870	1.46	¾ way across from Inwood	40 52 35	73 56 25	1	Flood	17.0	52	5.79	92
871	1.47	¾ way across from Inwood	40 52 35	73 56 25	20	Flood	17.0	52	5.89	94
872	1.49	¾ way across from Inwood	40 52 35	73 56 25	25	Flood	17.0	52	6.02	96

INTRODUCTION TO TABLES XXII, XXIII, XXIV, XXV, XXVI

The dissolved oxygen found in the year 1909 at various localities, depths and tides have been computed from the data contained in Table XXI. In Table XXV is given a summary of the results of these calculations. Tables XXII, XXIII and XXIV give the results used in making these averages. Table XXVI contains miscellaneous analyses not included elsewhere.

TABLE XXII

Average Volume and Percentage of Saturation of **Dissolved Oxygen in the Water** in the Year 1909

Averages for various parts of the harbor

The data for this table are contained in Table XXI.

Location	Number of analyses	Average C. C. per litre	Average per cent. of saturation	Samples included in the averages
Upper bay	80	4.03	68	191, 362–367, 374–381, 387–398, 421–422, 430–437, 444–451, 459–464, 539–541, 579–583, 762–771, 777–785, 796–797.
Hudson river, below Spuyten Duyvil	97	4.34	73	290–293, 423–429, 452–458, 471–510, 699–710, 846–872.
Hudson river above Spuyten Duyvil	32	5.05	83	67–78, 278–289, 511–518.
East river, below Hell Gate	135	3.82	66	163–182, 198–199, 242–277, 465–470, 542–556, 567–578, 772–776, 798–810, 820–845.
East river above Hell Gate	39	4.99	86	111–142, 557–561, 814–815.
Harlem river	54	3.21	55	51–66, 99–110, 240–241, 342–361, 816–819.
Long Island Sound	8	5.82	99	562–566, 811–813.
Kill van Kull	64	4.59	79	35–50, 382–385, 532–538, 584–593, 655–662, 681–682, 755–761, 786–795.
Newark bay	25	4.31	76	79–84, 93–98, 525–531, 649–654.
Passaic river at Newark	8	0.36	6	87–90, 519–520, 643–644. (Samples taken near N. Y. R.R. Avenue bridge only included.)
Arthur Kill	24	4.66	82	665–680, 747–754.
The Narrows	37	4.70	83	143–162, 311–313, 368–373, 399–400, 419–420, 438–439, 442–443.
Gravesend bay	17	5.00	90	294–297, 304–309. (298–303 and 310, taken in Coney Island creek or near disposal outlet, not included.)
Lower bay	118	5.40	97	314–315, 321–341, 401–406, 417–418, 440–441, 594–642, 711–746. (Raritan bay included in Lower bay.
Jamaica bay	42	4.04	72	206–215, 230, 232–233, 685–698. (216–229 and 231, taken in creeks or near large sewer outlets, not included.)
Rockaway inlet	14	5.62	101	200–205, 234–239.
Atlantic ocean, 10 miles off Long Branch	4	6.05	105	407–410.
Gowanus canal	2	0.00	0	187–188.
Newtown creek	3	0.00	0	183–185.
Wallabout canal		0.30	6	186.

TABLE XXIII

Average Volume and Percentage of Saturation of **Dissolved Oxygen in the Water** in the Year 1909

Averages of samples taken near Surface and Bottom for various parts of the harbor

The data for this table are contained in Table XXI.

Location	Depths							
	Surface				Bottom			
	No. of analyses	Average C. C. per litre	Average Per cent. saturation	Samples included in the averages	No. of analyses	Average C. C. per litre	Average per cent. saturation	Samples included in the averages
Upper bay	34	3.80	66	191, 362, 365, 374, 377, 380, 387, 389, 391, 393, 395, 397, 421, 430, 433, 435, 444, 447, 449, 459, 461, 463, 539, 579, 582, 762, 765, 767, 770, 777, 779, 782, 784, 796.	33	3.96	69	364, 367, 376, 379, 381, 388, 390, 392, 394, 396, 398, 422, 432, 434, 437, 446, 448, 451, 460, 462, 464, 541, 581, 583, 764, 766, 769, 771, 778, 781, 783, 785, 797.

TABLE XXIII—Continued

Location	Depths							
	Surface				Bottom			
	No. of analyses	Average C. C. per litre	Average per cent. saturation	Samples Included in the averages	No. of analyses	Average C. C. per litre	Average per cent. saturation	Samples included in the averages
Hudson river, below Spuyten Duyvil...	41	4.17	71	290, 292, 423, 425, 428, 452, 454, 457, 471, 473, 475, 477, 479, 481–483, 484, 486, 489, 491, 494, 496, 499, 501, 504, 506, 509, 699, 701, 704, 706, 709, 846, 849, 852, 855, 858, 861, 864, 867, 870.	38	4.30	73	291, 293, 424, 427, 429, 453, 456, 458, 472, 474, 476, 478, 480, 485, 488, 490, 493, 495, 498, 500, 503, 505, 508, 510, 700, 703, 705, 708, 710, 848, 851, 854, 857, 860, 863, 866, 869, 872.
Hudson river, above Spuyten Duyvil...	15	5.11	84	67, 69, 71, 73, 75, 77, 278, 280, 282, 284. 286, 288, 511, 514, 516	15	4.96	82	68, 70, 72, 74, 76, 78, 279, 281, 283, 285, 287, 289, 513, 515, 518.
East river, below Hell Gate.............	56	3.63	64	163, 165, 167, 169, 171, 173, 175, 177, 179, 181, 198, 242, 245, 247, 250, 252, 255, 257, 260, 263, 265, 268, 270, 273, 275, 465, 467, 469, 542, 544, 547, 549, 552, 554, 567, 569, 572, 574, 577, 772, 775, 798, 801, 803, 806, 808, 820, 823, 825, 827, 830, 833, 835, 838, 840, 843.	56	3.83	66	164, 166, 168, 170, 172, 174, 176, 178, 180, 182, 199, 244, 246, 249, 251, 254, 256, 259, 262, 264, 267, 269, 272, 274, 277, 466, 468, 470, 543, 546, 548, 551, 553, 556, 568, 571, 573, 576, 578, 774, 776, 800, 802, 805, 807, 810, 822, 824, 826, 829, 832, 834, 837, 839, 842, 845.
East river, above Hell Gate.............	19	5.01	86	111, 113, 115, 117, 119, 121, 132, 125, 127, 129, 131, 133, 135, 137, 139, 141, 557, 559, 814.	19	4.99	85	112, 114, 116, 118, 120, 122, 124, 126, 128, 130, 132, 134, 136, 138, 140, 142, 558, 561, 815.
Harlem river........	27	3.04	54	51, 53, 55, 57, 59, 61, 63, 65, 99, 101, 103, 105, 107, 109, 240, 342, 344, 346, 348, 350, 352, 354, 356, 358, 360, 816, 818.	27	3.26	57	52, 54, 56, 58, 60, 62, 64, 66, 100, 102, 104, 106, 108, 110, 241, 343, 345, 347, 349, 351, 353, 355, 357, 359, 361, 817, 819.
Long Island Sound, near Throgs Neck..	3	5.69	98	562, 564, 811.	3	5.92	100	563, 566, 813.
Kill van Kull........	28	4.37	78	35, 37, 39, 41, 43, 45, 47, 49, 382, 384, 532, 534, 537, 584, 587, 589, 592, 655, 658, 660, 681, 755, 757, 760, 786, 789, 791, 794.	28	4.74	81	36, 38, 40, 42, 44, 46, 48, 50, 383, 385, 533, 536, 538, 586, 588, 591, 593, 657, 659, 662, 682, 756, 759, 761, 788, 790, 793, 795.
Newark bay.........	12	4.29	76	79, 81, 83, 93, 95, 97, 525, 527, 529, 649, 651, 653.	12	4.37	77	80, 82, 84, 94, 96, 98, 526, 528, 531, 650, 652, 654.
Passaic river at Newark...........	4	0.33	6	87, 89, 519, 643.	4	0.40	7	88, 90, 520, 644.
Arthur Kill..........	12	4.52	80	665, 667, 669, 671, 673, 675, 677, 679, 747, 749, 751, 753.	12	4.81	84	666, 668, 670, 672, 674, 676, 678, 680, 748, 750, 752, 754.
The Narrows........	17	4.86	86	143, 145, 147, 149, 151, 153, 155, 157, 159, 161, 311, 368, 371, 399, 419, 438, 442.	17	4.55	80	144, 146, 148, 150, 152, 154, 156, 158, 160, 162, 313, 370, 373, 400, 420, 439, 443.
Gravesend bay......	8	4.82	88	294, 296, 304–309. (310, taken near sewer outlet not included.)	—	—	—	(295, 297, only deep samples. Water shallow.)
Lower bay..........	64	5.23	93	314, 321–322, 324, 326, 328–333, 335, 337, 339–341, 401, 403, 405, 417, 440, 441, 594, 597, 599, 601, 603, 605, 607, 609, 611, 613, 615, 617, 619, 621, 623, 625, 627, 629, 631, 633, 635, 637, 639, 641, 711, 713, 715, 717, 719, 721, 723, 725, 727, 729, 731, 733, 735, 737, 739, 741, 743, 745.	53	5.61	100	315, 323, 325, 327, 334, 336, 338, 402, 404, 406, 418, 596, 598, 600, 602, 604, 606, 608, 610, 612, 614, 616, 618, 620, 622, 624, 626, 628, 630, 632, 634, 636, 638, 640, 642, 712, 714, 716, 718, 720, 722, 724, 726, 728, 730, 732, 734, 736, 738, 740, 742, 744, 746.
Jamaica bay........	19	3.90	69	206, 208, 210, 212, 213, 214, 215, 230, 232–233, 685, 687, 689, 691, 693, 695–698. (216–229, taken in creeks or near sewer outlets, not included.)	—	—	—	(207, 209, 211, 686, 688, 690, 692, 694 were only bottom samples taken. Water shallow.)
Rockaway inlet......	6	5.58	101	200, 202, 204, 234, 236, 238. (683, near shore, not included.)	6	5.60	103	201, 203, 205, 235, 237, 239. (684, near shore, not included.)
Atlantic ocean.......	2	6.21	111	407, 409.	2	5.89	100	408, 410.
Gowanus canal......	2	0.00	0	187–188.	—	—	—	No deep samples.
Newtown creek.	3	0.00	0	183–185.	—	—	—	No deep samples.
Wallabout canal.....	1	0.30	6	186.	—	—	—	No deep samples.

TABLE XXIV

Average Volume and Percentage of Saturation of **Dissolved Oxygen in the Water** in the Year 1909

Averages of samples taken on Ebb and Flood Currents, for various parts of the harbor

The data for this table are contained in Table XXI.

Location	Currents							
	Ebb Currents				Flood Currents			
	No. of analyses	Average C. C. per litre	Average per cent. saturation	Samples included in the averages	No. of analyses	Average C. C. per litre	Average per cent. saturation	Samples included in the averages
Upper bay..........	48	3.88	65	191, 362–367, 380–381, 387–394, 395–398, 421–422, 444–451, 539–541, 579–583, 777–785.	32	4.26	71	374–379, 430–437, 459–464, 762–771, 796–797.
Hudson river, below Spuyten Duyvil...	29	3.67	66	290–293, 452–458, 471–483, 494–498.	68	4.63	76	423–429, 484–493, 499–510, 699–710, 846–872.
Hudson river, above Spuyten Duyvil...	10	5.13	83	67–72, 286–289.	22	5.01	84	73–78, 278–285, 511–518.
East river, below Hell Gate.............	63	3.53	61	173–182, 242–259, 542–548, 567–578, 820–829.	72	4.08	70	163–172, 198–199, 260–277, 465–470, 549–556, 772–776, 798–810, 830–845.
East river, above Hell Gate.............	18	5.38	92	117–122, 133–142, 814–815.	21	4.66	80	111–116, 123–132, 557–561.
Harlem river........	32	3.21	55	51–60, 105–110, 240–241, 342–351, 816–819.	22	3.21	55	61–66, 99–104, 352–361.
Long Island Sound, near Throgs Neck..	3	5.90	100	811–813.	5	5.78	99	562–566.
Kill van Kull........	40	4.49	78	35–40, 382–385, 584–593, 655–662, 681–682, 786–795.	24	4.76	82	41–50, 532–538, 755–761.
Newark Bay........	12	4.21	74	79–84, 649–654.	13	4.41	78	93–98, 525–531.
Passaic river at Newark...........	4	0.30	5	87–88, 643–644.	4	0.42	7	89–90, 519–520.
Arthur Kill.........	16	4.31	73	665–680.	8	5.61	100	747–754.
The Narrows........	19	4.16	74	153–162, 368–370, 399–400, 419–420, 442–443.	18	5.18	92	143–152, 311–313, 371–373, 438–439.
Gravesend bay......	—	—	—	(299–303 ,taken in Coney Island creek and near outlet of disposal plant, not included.)	10	5.00	90	294–297, 304–309. (298 and 310, taken near outlet of disposal plant, not included.)
Lower bay..........	59	5.29	95	328–336, 401–402, 417–418, 594–606, 621–642, 725–734.	59	5.56	100	314–315, 321–327, 337–341, 403–406, 440–441, 607–620, 711–724, 735–746.
Jamaica bay........	16	3.80	67	214, 215, 685–698. (216–219 and 223–229, taken in creeks or near sewer outlets, not included.)	11	4.20	80	206–213, 230, 232–233. (220–222, taken near sewer outlets, not included.)
Rockaway inlet......	6	5.10	93	200–205. (683–684, taken near shore, not included.)	6	6.14	111	234–239.
Atlantic oceans......	—	—	—	No samples taken on the ebb.	4	6.05	105	407–410.
Gowanus canal......	2	0.00	0	187–188.	—	—	—	No samples taken on the flood.
Newtown creek......	—	—	—	No samples taken on the ebb.	3	0.00	0	183–185.
Wallabout canal.....	—	—	—	No samples taken on the ebb.	1	0.30	6	186.

TABLE XXV

Average Volume and Percentage of Saturation of Dissolved Oxygen in the Water in the Year 1909

Summary of Tables XXII, XXIII and XXIV

The data for this table are contained in Table XXI.

Location	All Depths and Tides			Depths						Currents					
				Surface			Bottom			Ebb			Flood		
	No. of analyses	Averages C. C. per litre	Averages per cent. saturation	No. of analyses	Average C. C. per litre	Averages per cent. saturation	No. of analyses	Average C. C. per litre	Average per cent. saturation	No. of analyses	Average C. C. per litre	Average per cent. saturation	No. of analyses	Average C. C. per litre	Average per cent. saturation
Upper bay	80	4.03	68	34	3.80	66	33	3.96	69	48	3.88	65	32	4.26	71
Hudson river, below Spuyten Duyvil	97	4.34	73	41	4.17	71	38	4.30	73	29	3.67	66	68	4.63	76
Hudson river, above Spuyten Duyvil	32	5.05	83	15	5.11	84	15	4.96	82	10	5.13	83	22	5.01	84
East river below Hell Gate	135	3.82	66	56	3.63	64	56	3.83	66	63	3.53	61	72	4.08	70
East river above Hell Gate	39	4.99	86	19	5.01	86	19	4.99	85	18	5.38	92	21	4.66	80
Harlem river	54	3.21	55	27	3.04	54	27	3.26	57	32	3.21	55	22	3.21	55
Long Island Sound	8	5.82	99	3	5.69	98	3	5.92	100	3	5.90	100	5	5.78	99
Kill van Kull	64	4.59	79	28	4.37	78	28	4.74	81	40	4.49	78	24	4.76	82
Newark bay	25	4.31	76	12	4.29	76	12	4.37	77	12	4.21	74	13	4.41	78
Passaic river at Newark	8	0.36	6	4	0.33	6	4	0.40	7	4	0.30	5	4	0.42	7
Arthur Kill	24	4.66	82	12	4.52	80	12	4.81	84	16	4.31	73	8	5.61	100
The Narrows	37	4.70	83	17	4.86	86	17	4.55	80	19	4.16	74	18	5.18	92
Gravesend bay	17	5.00	90	8	4.82	88	—	—	—	—	—	—	10	5.00	90
Lower bay	118	5.40	97	64	5.23	93	53	5.61	100	59	5.29	95	59	5.56	100
Jamaica bay	42	4.04	72	19	3.90	69	—	—	—	16	3.80	67	11	4.20	80
Rockaway inlet	14	5.62	101	6	5.58	101	6	5.60	103	6	5.10	93	6	6.14	111
Atlantic ocean, 10 miles off Long Branch	4	6.05	105	2	6.21	111	2	5.89	100	—	—	—	4	6.05	105
Gowanus canal	2	0.00	0	2	0.00	0	—	—	—	2	0.00	0	—	—	—
Newtown creek	3	0.00	0	3	0.00	0	—	—	—	—	—	—	3	0.00	0
Wallabout canal	1	0.30	6	1	0.30	6	—	—	—	—	—	—	1	0.30	6

TABLE XXVI

Average Volume and Percentage of Saturation of Dissolved Oxygen in the Water in the Year 1909

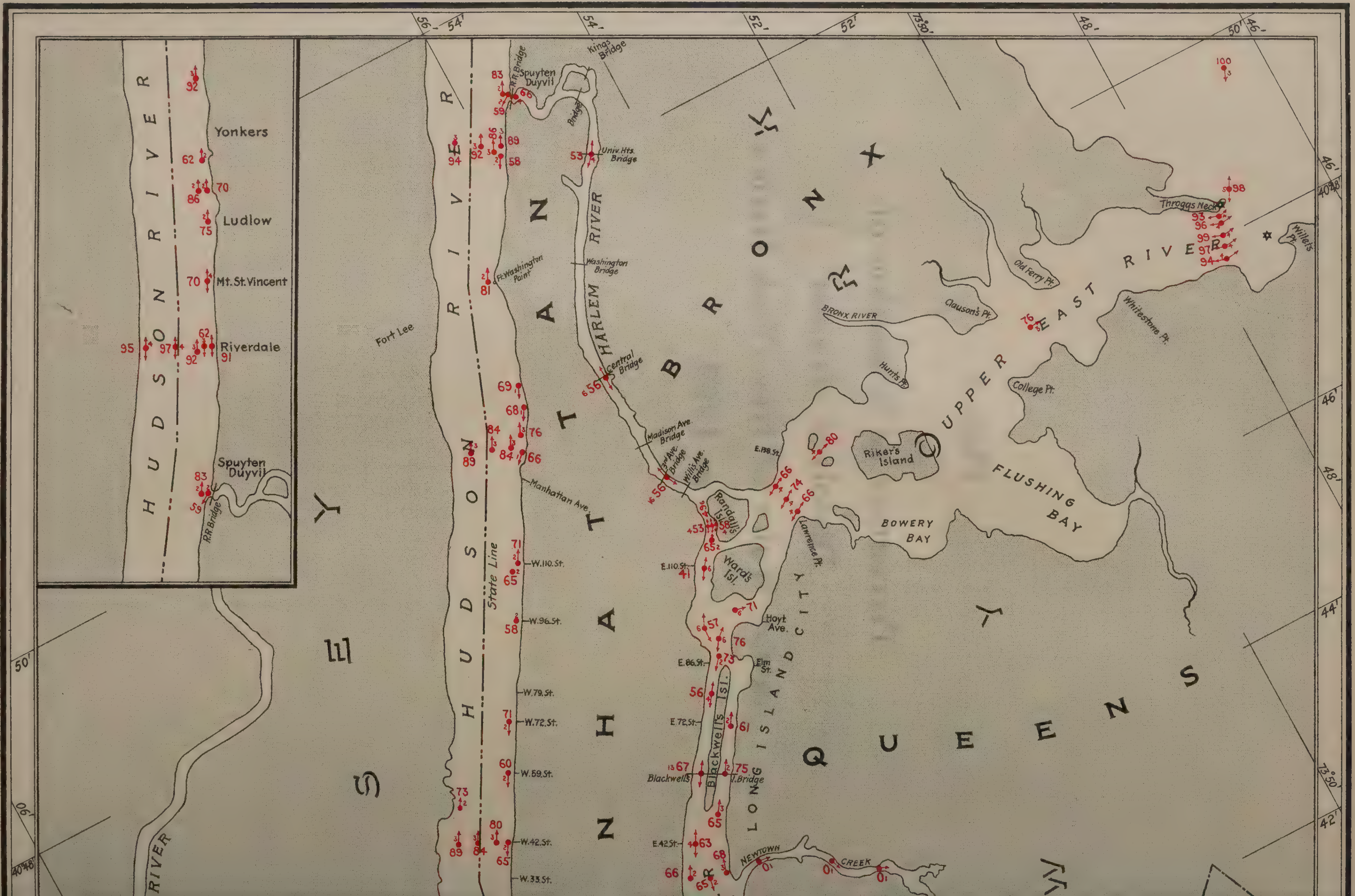
Averages of samples taken at miscellaneous locations in the harbor

The data for this table are contained in Table XXI.

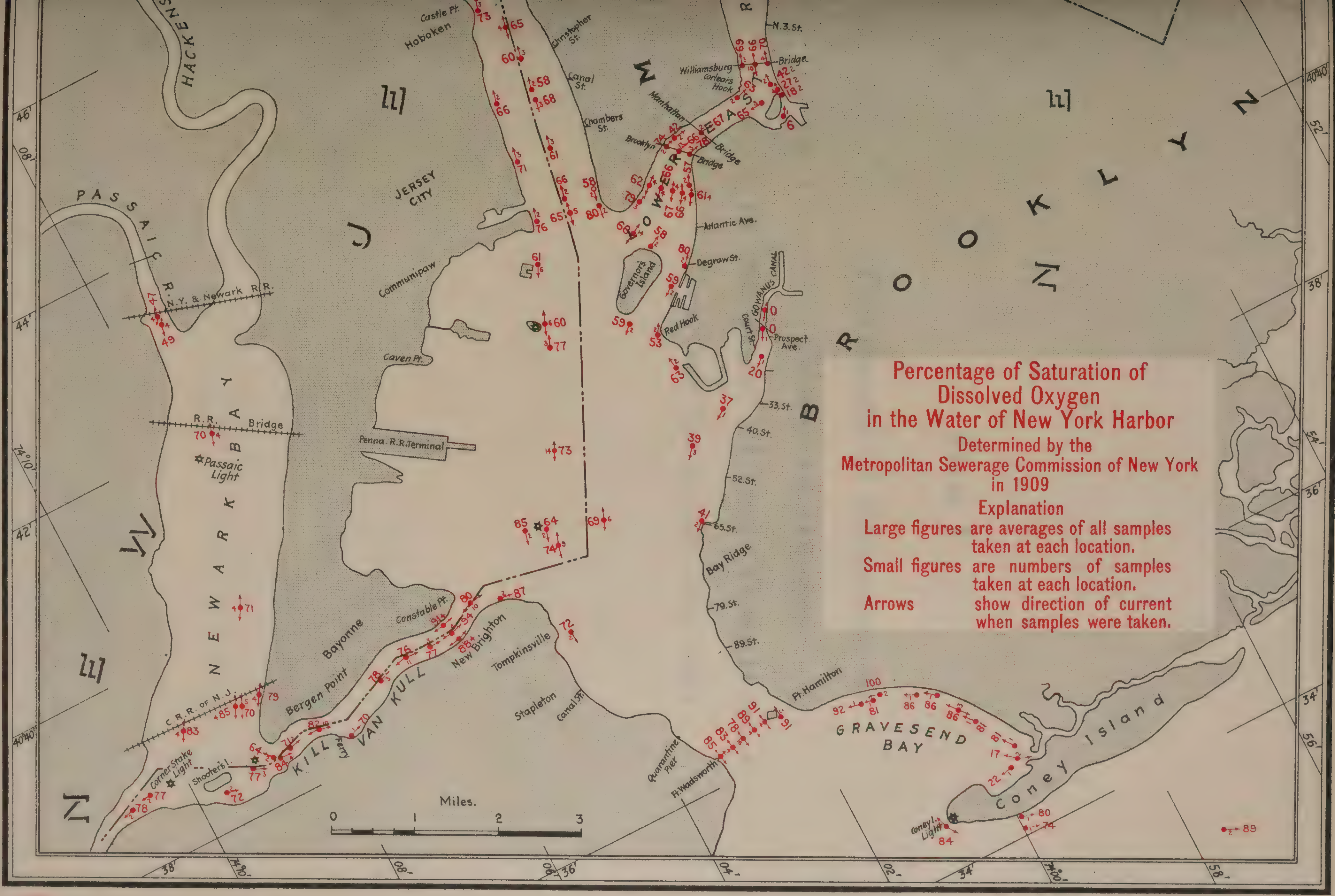
Location	Number of analyses	Average C. C. per litre	Average per cent. of saturation	Samples included in the averages
Atlantic ocean, off Sandy Hook	6	6.20	112	411–416.
Passaic river, below Newark	12	2.36	41	85–86, 91–92, 521–524, 645–648.
Shrewsbury river	5	5.76	105	316–320.
Rahway river	2	3.54	59	663–664.
Bodine creek	1	3.86	70	386.
Gowanus bay	2	1.55	28	189–190.
Wallabout bay	6	1.65	29	192–197.
				NOTE.—All samples collected in these regions are included in averages.
Total	34			
Total in previous tables	804			NOTE.—The series begins with sample No. 35.
Total analyses	838			
	782			
	34			
Total used in averages	816			

Plate E

Percentage of Saturation of Dissolved Oxygen in the Water of New York Harbor in 1909



HUDSON RIVER
Yonkers
Ludlow
Mt. St. Vincent
Riverdale
Spuyten Duyvil
R.R. Bridge
Kings Bridge
Bridge
Univ. Hts. Bridge
Washington Bridge
HARLEM RIVER
Central Bridge
Madison Ave. Bridge
3rd Ave. Bridge
Willis Ave. Bridge
Ft. Washington Point
Fort Lee
Manhattan Ave.
W. 110 St.
W. 96 St.
W. 79 St.
W. 72 St.
W. 59 St.
W. 42 St.
W. 33 St.
State Line
NEW JERSEY
MANHATTAN
BRONX
QUEENS
LONG ISLAND CITY
E. 138 St.
E. 110 St.
E. 86 St.
E. 72 St.
E. 42 St.
Randall's Isl.
Ward's Isl.
Blackwell's Isl.
Blackwell's Bridge
Hoyt Ave.
Elm St.
Lawrence Pt.
NEWTOWN CREEK
Riker's Island
BOWERY BAY
FLUSHING BAY
UPPER EAST RIVER
BRONX RIVER
Hunts Pt.
Clauson's Pt.
Old Ferry Pt.
College Pt.
Whitestone Pt.
Throggs Neck
Willets Pt.
RIVER
56'
54'
52'
50'
48'
46'
44'
42'
06'
73°50'
40°48'



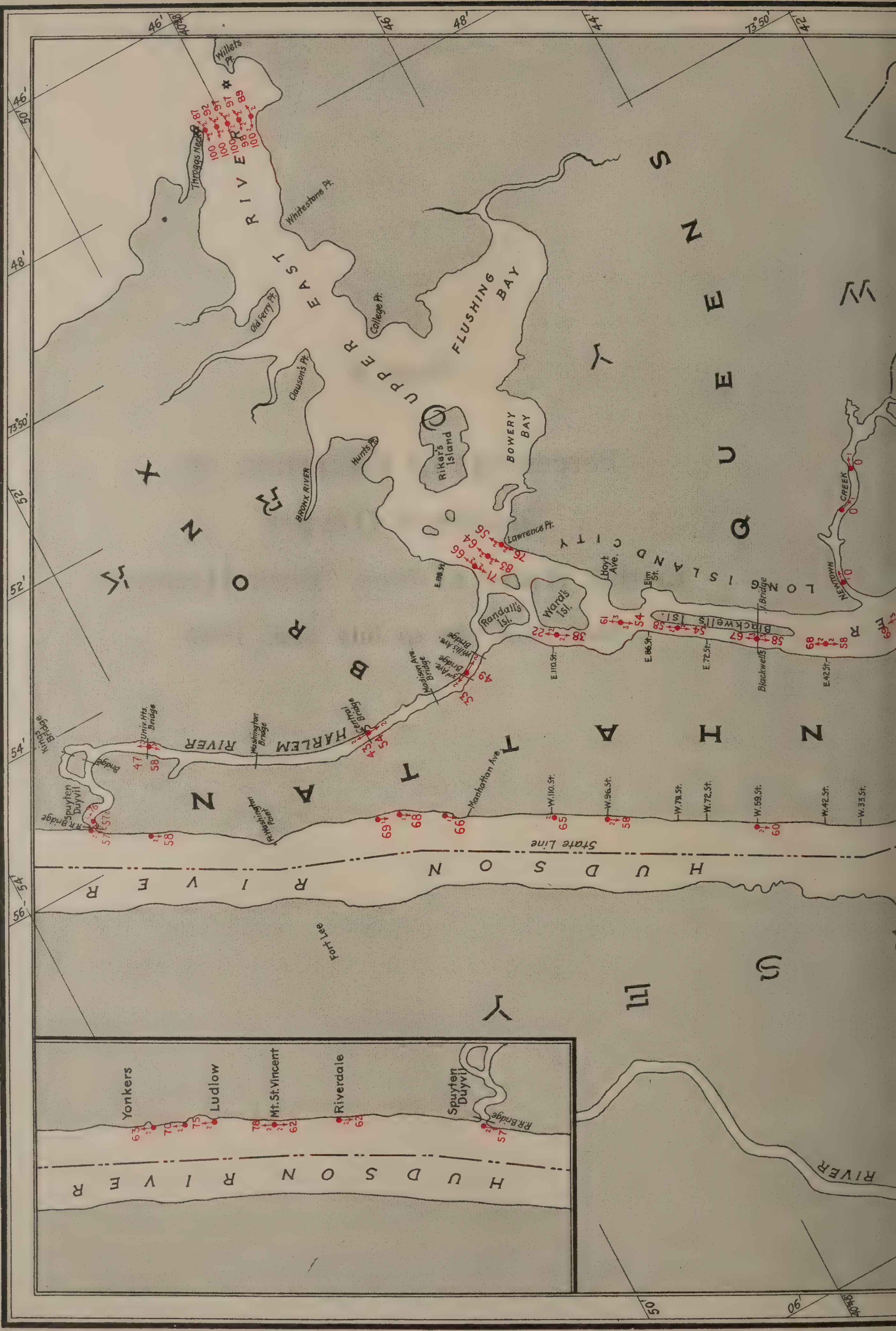
E

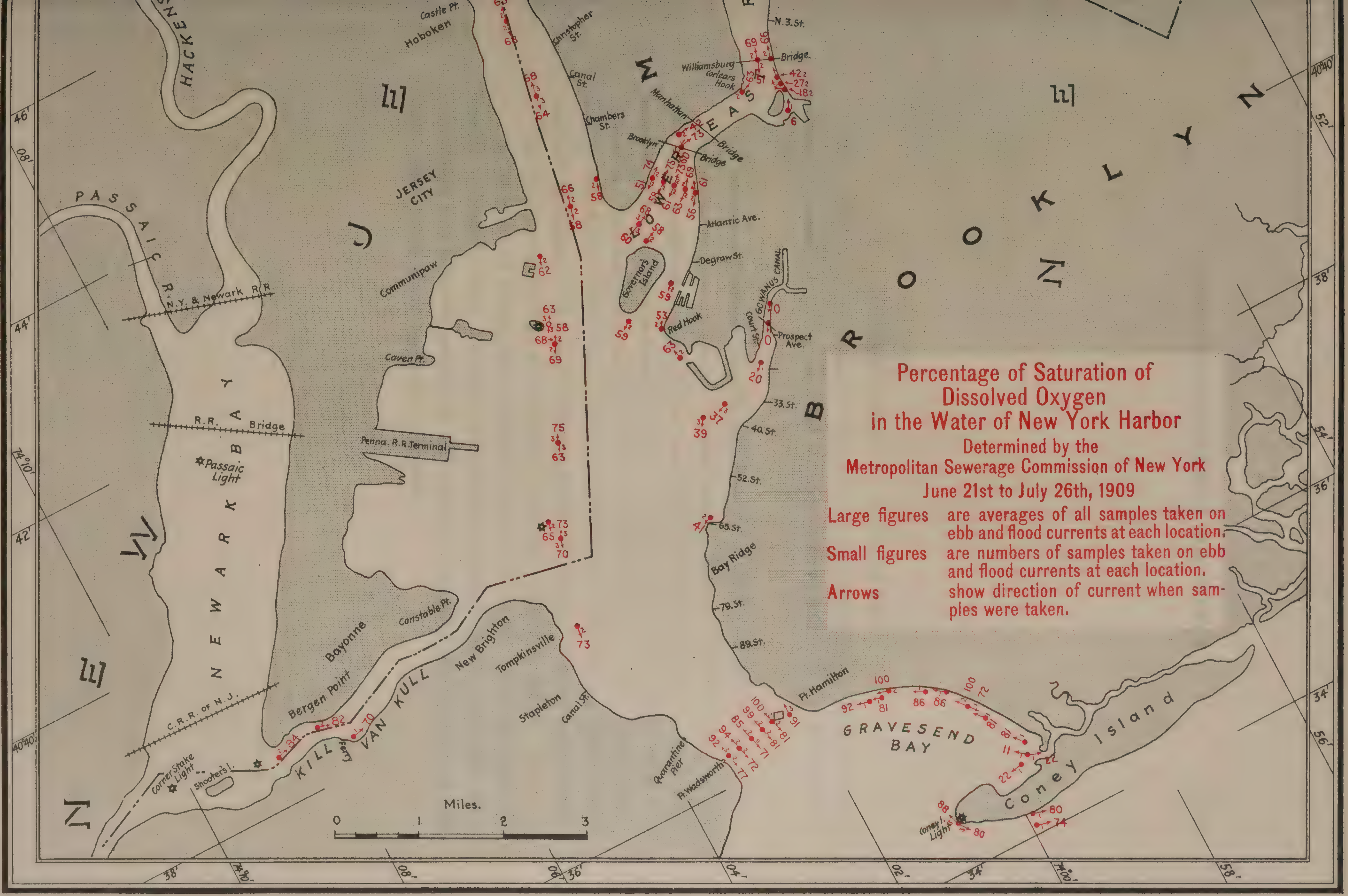
Plotted from Data Contained in Table XXI, pp. 308–336.

Plate F

Percentage of Saturation of Dissolved Oxygen in the Water of New York Harbor

from June 21st to July 26th, 1909


BRONX
QUEENS
MANHATTAN
NEW JERSEY
EAST RIVER
UPPER EAST RIVER
FLUSHING BAY
BOWERY BAY
HARLEM RIVER
HUDSON RIVER
State Line
Willets Pt.
Throggs Neck
Whitestone Pt.
Old Ferry Pt.
Clausen's Pt.
College Pt.
Hunts Pt.
BRONX RIVER
Riker's Island
Lawrence Pt.
LONG ISLAND CITY
Hoyt Ave.
Elm St.
Randall's Isl.
Ward's Isl.
Blackwell's Isl.
Blackwells Bridge
NEWTOWN CREEK
E.138 St.
E.110 St.
E.86 St.
E.72 St.
E.42 St.
Willis Ave. Bridge
3rd Ave. Bridge
Madison Ave. Bridge
Central Bridge
Washington Bridge
Univ. Hts. Bridge
Kings Bridge
Bridge
Spuyten Duyvil
R.R. Bridge
Ft. Washington Point
Manhattan Ave.
W.110 St.
W.96 St.
W.79 St.
W.72 St.
W.59 St.
W.42 St.
W.33 St.
Fort Lee
Yonkers
Ludlow
Mt. St. Vincent
Riverdale
46'
40°48'
48'
44'
73°50'
42'
50'
52'
54'
56'
06'
40°08'



Percentage of Saturation of Dissolved Oxygen in the Water of New York Harbor

Determined by the Metropolitan Sewerage Commission of New York

June 21st to July 26th, 1909

Large figures	are averages of all samples taken on ebb and flood currents at each location.
Small figures	are numbers of samples taken on ebb and flood currents at each location.
Arrows	show direction of current when samples were taken.

Plotted from Data Contained in Table XXI, pp. 310–323.

INTRODUCTION TO TABLE XXVII

The analyses for oxygen made in the year 1911 were made in the same manner and by the same persons as in the year 1909, but there was some difference in the scheme of collection.

Difference Between General Scheme of Collection in 1909 and 1911

More observations were made in cross sections of the channels in 1911 than in 1909 and attention was not confined to New York harbor in 1911; a trip on which many samples were collected was made through Long Island Sound and around Cape Cod to Boston. The chief object of the Boston trip was to study the effects of discharging sewage into Boston harbor from the three outfalls of the main drainage system which was built to dispose of the sewage of Boston and of many cities and towns in its vicinity.

In all essential respects, Table XXVII is uniform with Table XXI.

In 1911, several groups of samples were collected in Upper New York bay in the vicinity of Robbins Reef. The object in taking these samples was to secure data which might serve as a basis for comparison with samples to be collected in future in case the Passaic Valley sewer was put in operation.

TABLE XXVII

VOLUME AND PERCENTAGE OF SATURATION OF DISSOLVED OXYGEN IN THE WATER IN THE YEAR 1911

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Section No.	Location	Date of Collection	Page
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3	Hudson river	June 28, 1911	345
4	Hudson river	June 29, 1911	346
5	East river	June 30, 1911	346
6	East river	June 30, 1911	347
7	East river	June 30, 1911	347
8	East river	July 5, 1911	347
9	Gowanus canal	July 6, 1911	348
10	Hudson river	July 7, 1911	349
11	Harlem river	July 10, 1911	350
12	Buttermilk channel	July 11, 1911	351
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14	Buttermilk channel	July 13, 1911	353
15	Governor's island to Atlantic ocean	July 13, 1911	354
16	Governor's island to Atlantic ocean	July 14, 1911	355
17	Kill van Kull	July 17, 1911	356
18	East river	July 18, 1911	357
19	Hudson river	July 19, 1911	358
20	Hudson river	July 20, 1911	358
21	East river	July 21, 1911	359
22	Hudson river	July 25, 1911	360
23	Hudson river	July 26, 1911	360
24	East river	July 27, 1911	361
25	East river	July 28, 1911	362
26	Buttermilk channel	July 31, 1911	363
27	Gowanus canal	July 31, 1911	364
28	East river and Long Island Sound	Aug. 1, 1911	364
29	Manhasset bay	Aug. 1, 1911	364
30	Long Island Sound and East river	Aug. 1, 1911	365
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34	Raritan bay	Aug. 2, 1911	367
35	East river	Aug. 3, 1911	367
36	East river	Aug. 4, 1911	368
37	Harlem river	Aug. 4, 1911	368
38	Kill van Kull	Aug. 8, 1911	369
39	Newark bay	Aug. 8, 1911	369
40	Passaic river	Aug. 8, 1911	370
41	The Narrows	Aug. 9, 1911	370
42	Hudson river	Aug. 10, 1911	371
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51	Boston Outer harbor in the vicinity of Deer Islind light	Aug. 28, 1911	381
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54	Boston Inner harbor and Charles river	Aug. 29, 1911	382
55	Boston Outer harbor in the vicinity of Deer Island light	Aug. 29, 1911	383
56	Boston Outer harbor in the vicinity of Deer Island light	Aug. 30, 1911	383
57	Boston Outer harbor, off Peddock's Island	Sept. 5, 1911	384
58	Boston Outer harbor, off Moon Head	Sept. 6, 1911	384
59	Boston Outer harbor, off Peddock's Island	Sept. 7, 1911	385
60	Boston Outer harbor, off Moon Head	Sept. 7, 1911	385
61	Charles river at Boston	Sept. 8, 1911	386
62	Boston Outer harbor, off Peddock's Island	Sept. 9, 1911	386
63	Boston Outer harbor, off Peddock's Island	Sept. 11, 1911	386
64	Boston Outer harbor, off Moon Head	Sept. 11, 1911	387
65	Boston Outer harbor, off Peddock's Island	Sept. 12, 1911	387
66	Charles river, Boston	Sept. 13, 1911	389
67	Boston Outer harbor, off Peddock's Island	Sept. 14, 1911	389
68	Boston Outer harbor, off Moon Island	Sept. 14, 1911	390
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70	Boston Outer harbor, off Moon Head	Sept. 15, 1911	392
71	Boston Outer harbor, off Moon Head	Sept. 18, 1911	392
72	The Narrows	Sept. 26, 1911	393
73	Hudson river	Sept. 28, 1911	395
74	East river	Sept. 29, 1911	398
75	Kill van Kull	Oct. 4, 1911	400
76	Newark vay	Oct. 6, 1911	401
77	East river	Oct. 11, 1911	402
78	Hudson river	Oct. 13, 1911	403
79	Upper bay	Oct. 16, 1911	405
80	Upper bay	Oct. 23, 1911	406
81	Upper bay	Oct. 24, 1911	407
82	East river	Oct. 25, 1911	409
83	Upper bay	Oct. 26, 1911	410
84	Hudson river	Oct. 27, 1911	411
85	Slips, etc	Oct. 30, 1911	411
86	The Narrows	Nov. 1, 1911	412
87	Harlem river	Nov. 2, 1911	412
88	East river	Nov. 3, 1911	412
89	East river and Long Island Sound	Nov. 8, 1911	413
90	Buttermilk channel	Nov. 9, 1911	413
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97	East river, Upper bay and Lower bay	Nov. 17, 1911	414
98	East river	Nov. 20, 1911	414

TABLE XXVII

Volume and Percentage of Saturation of **Dissolved Oxygen in the Water** in the Year 1911

1—BUTTERMILK CHANNEL. JUNE 27, 1911.

High water at Governor's Island at 8.33 A. M. Low water at 2.57 P. M.

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
1	11.00	Slip just east of Pier 32, East river, Brooklyn	40 41 15	74 00 26	1	Ebb	20.5	36	1.56	27
2	11.02	Slip just east of Pier 32, East river, Brooklyn	40 41 15	74 00 26	10	Ebb	20.5	36	1.56	27
3	11.20	Buttermilk channel, 200 feet off Pier 29, Brooklyn	40 41 22	74 00 26	1	Ebb	20.0	34	3.11	54
4	11.23	Buttermilk channel, 200 feet off Pier 29, Brooklyn	40 41 22	74 00 26	20	Ebb	20.0	34	3.11	54
5	11.30	Buttermilk channel, 200 feet off Pier 29, Brooklyn	40 41 22	74 00 26	35	Ebb	20.0	34	3.11	54
6	12.00 P. M.	Buttermilk channel, 200 feet off outer end of De Graw st. slip	40 41 15	74 00 32	1	Ebb	20.0	34	2.49	43
7	12.02	Buttermilk channel, 200 feet off outer end of De Graw st. slip	40 41 15	74 00 32	20	Ebb	20.0	34	2.49	43
8	12.05	Buttermilk channel, 200 feet off outer end of De Graw st. slip	40 41 15	74 00 32	35	Ebb	20.0	34	2.49	43
9	12.30	Buttermilk channel, 200 feet off east end of Pier 33, Brooklyn	40 41 11	74 00 35	1	Ebb	20.0	34	2.49	43
10	12.32	Buttermilk channel, 200 feet off east end of Pier 33, Brooklyn	40 41 11	74 00 35	20	Ebb	20.0	34	2.49	43
11	12.35	Buttermilk channel, 200 feet off east end of Pier 33, Brooklyn	40 41 11	74 00 35	30	Ebb	20.0	34	2.49	43

2—GOWANUS CANAL. JUNE 27, 1911

High water at Governor's Island at 8.33 A. M. Low water at 2.57 P. M.

12	P. M. 1.20	Gowanus canal, at its mouth, foot of 25th st., Brooklyn	40 39 55	74 00 25	1	Flood	20.5	34	2.18	38
13	1.23	Gowanus canal at its mouth, foot of 25th st., Brooklyn	40 39 55	74 00 25	10	Flood	20.5	34	2.18	38
14	1.45	Gowanus canal at Hamilton ave. bridge	40 40 17	73 59 56	1	Flood	20.5	34	0.47	8
15	1.48	Gowanus canal at Hamilton ave. bridge	40 40 17	73 59 56	10	Flood	20.5	34	0.47	8
16	2.00	Gowanus canal at 9th st. bridge	40 40 25	73 59 50	1	Flood	20.5	34	0.00	0
17	2.03	Gowanus canal at 9th st. bridge	40 40 25	73 59 50	10	Flood	20.5	34	0.00	0
18	2.30	Gowanus canal at Hamilton ave. bridge	40 40 17	73 59 56	1	Flood	20.5	34	0.94	16
19	2.35	Gowanus canal at Hamilton ave. bridge	40 40 17	73 59 56	10	Flood	20.5	34	1.24	21

3—HUDSON RIVER. JUNE 28, 1911

High water at Governor's Island at 9.03.

20	P. M. 5.10	Hudson river, 500 feet off Inwood	40 32 15	73 56 00	1	Ebb	22.0	76	3.43	57
21	5.15	Hudson river, 500 feet off Inwood	40 32 15	73 56 00	1	Ebb	22.0	76	3.96	66
22	5.20	Hudson river, 500 feet off Inwood	40 32 15	73 56 00	30	Ebb	22.0	68	3.74	62

TABLE XXVII—Continued

4—HUDSON RIVER CROSS-SECTION AT MT. ST. VINCENT. JUNE 29, 1911

High water at Governor's Island at 10.23 A. M. Low water at 4.47 P. M.

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
23	9.40	300 feet off Mt. St. Vincent dock.....	40 54 50	73 54 46	1	Flood	22.0	84	4.05	68
24	9.42	300 feet off Mt. St. Vincent dock.....	40 54 50	73 54 46	20	Flood	22.0	80	3.74	62
25	9.45	300 feet off Mt. St. Vincent dock.....	40 54 50	73 54 46	30	Flood	22.0	76	3.74	62
26	10.10	¼ way across from New York shore...	40 54 50	73 54 59	1	Flood	22.0	80	4.05	68
27	10.12	¼ way across from New York shore...	40 54 50	73 54 59	20	Flood	22.0	72	3.74	62
28	10.15	¼ way across from New York shore...	40 54 50	73 54 59	40	Flood	22.0	72	3.74	62
29	10.40	Midstream........................	40 54 50	73 55 15	1	Flood	22.0	80	4.05	68
30	10.42	Midstream........................	40 54 50	73 55 15	20	Flood	22.0	72	4.05	68
31	10.45	Midstream........................	40 54 50	73 55 15	30	Flood	22.0	72	4.05	68
32	11.20	¾ way across from New York shore...	40 54 50	73 55 30	1	Flood	22.0	80	4.33	72
33	11.22	¾ way across from New York shore...	40 54 50	73 55 30	10	Flood	22.0	76	4.05	68
34	11.25	¾ way across from New York shore...	40 54 50	73 55 30	20	Flood	22.0	72	4.05	68
35	11.55	300 feet off New Jersey shore.........	40 54 50	73 55 42	1	Flood	22.0	80	4.33	72
36	11.57	300 feet off New Jersey shore.........	40 54 50	73 55 42	10	Flood	22.0	76	4.33	72
37	12.00	300 feet off New Jersey shore.........	40 54 50	73 55 42	15	Flood	22.0	76	4.33	72
38	P. M. 3.20	300 feet off Mt. St. Vincent dock.....	40 54 50	73 54 46	1	Ebb	23.0	80	4.05	68
39	3.23	300 feet off Mt. St. Vincent dock.....	40 54 50	73 54 46	20	Ebb	23.0	76	4.05	68
40	3.25	300 feet off Mt. St. Vincent dock.....	40 54 50	73 54 46	30	Ebb	23.0	72	3.74	62
41	3.52	¼ way across from New York shore...	40 54 50	73 54 59	1	Ebb	23.0	80	4.05	68
42	3.53	¼ way across from New York shore...	40 54 50	73 54 59	20	Ebb	23.0	76	4.05	68
43	3.55	¼ way across from New York shore...	40 54 50	73 54 59	40	Ebb	23.0	72	3.74	62
44	4.10	Midstream........................	40 54 50	73 55 15	1	Ebb	23.0	80	4.33	72
45	4.12	Midstream........................	40 54 50	73 55 15	20	Ebb	23.0	76	4.33	72
46	4.15	Midstream........................	40 54 50	73 55 15	30	Ebb	23.0	72	4.05	68
47	4.30	¾ way across from New York shore...	40 54 50	73 55 30	1	Ebb	23.0	84	4.68	78
48	4.32	¾ way across from New York shore...	40 54 50	73 55 30	10	Ebb	23.0	80	4.33	72
49	4.35	¾ way across from New York shore...	40 54 50	73 55 30	20	Ebb	23.0	76	4.05	68
50	4.50	300 feet off New Jersey shore.........	40 54 50	73 55 42	1	Ebb	23.0	84	4.68	78
51	4.52	300 feet off New Jersey shore.........	40 54 50	73 55 42	10	Ebb	23.0	80	4.33	72
52	4.55	300 feet off New Jersey shore.........	40 54 50	73 55 42	15	Ebb	23.0	76	4.33	72

5—EAST RIVER CROSS SECTION FROM COLLEGE POINT TO CLASON POINT. JUNE 30, 1911

High water at Governor's Island at 11.23 A. M. Low water at 5.27 P. M. High water at Hell Gate at 1.20 P. M. Low water at 7.15 P. M.

53	A. M. 11.00	200 feet off Clason Point dock........	40 48 15	73 51 11	1	Flood	20.0	28	3.43	60
54	11.02	200 feet off Clason Point dock........	40 48 15	73 51 11	20	Flood	20.0	28	3.27	57
55	11.04	200 feet off Clason Point dock........	40 48 15	73 51 11	40	Flood	20.0	26	3.11	55
56	11.25	¼ way across from Clason Point......	40 48 09	73 51 11	1	Flood	20.0	28	3.43	60
57	11.27	¼ way across from Clason Point......	40 48 09	73 51 11	20	Flood	20.0	28	3.27	57
58	11.30	¼ way across from Clason Point......	40 48 09	73 51 11	40	Flood	20.0	26	3.11	55
59	11.46	Midstream........................	40 48 00	73 51 11	1	Flood	20.0	28	3.11	55
60	11.48	Midstream........................	40 48 00	73 51 11	20	Flood	20.0	28	3.11	55
61	11.50	Midstream........................	40 48 00	73 51 11	40	Flood	20.0	26	3.11	55
62	P. M. 12.06	¾ way across from Clason Point......	40 47 51	73 51 11	1	Flood	20.0	28	3.11	55
63	12.08	¾ way across from Clason Point......	40 47 51	73 51 11	20	Flood	20.0	26	3.11	55
64	12.10	¾ way across from Clason Point......	40 47 51	73 51 11	40	Flood	20.0	26	3.11	55
65	12.26	300 feet off College Point...........	40 47 44	73 51 11	1	Flood	20.0	28	3.11	55
66	12.28	300 feet off College Point...........	40 47 44	73 51 11	20	Flood	20.0	26	3.27	57
67	12.30	300 feet off College Point...........	40 47 44	73 51 11	35	Flood	20.0	26	3.27	57

TABLE XXVII—Continued

6—EAST RIVER CROSS SECTION FROM OLD FERRY POINT TO WHITESTONE POINT. JUNE 30, 1911

High water at Governor's Island at 11.23 A. M. Low water at 5.27 P. M. High water at Hell Gate at 1.20 P. M. Low water at 7.15 P. M.

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
68	1.00	500 feet off Old Ferry Point..........	40 48 16	73 49 49	1	Ebb	21.0	24	4.68	85
69	1.02	500 feet off Old Ferry Point..........	40 48 16	73 49 49	20	Ebb	21.0	24	4.68	85
70	1.04	500 feet off Old Ferry Point..........	40 48 16	73 49 49	50	Ebb	21.0	24	5.00	91
71	1.16	Midstream..........................	40 48 10	73 49 33	1	Ebb	21.0	24	4.68	85
72	1.18	Midstream..........................	40 48 10	73 49 33	20	Ebb	21.0	24	4.68	85
73	1.20	Midstream..........................	40 48 10	73 49 33	50	Ebb	21.0	24	5.00	91
74	1.36	500 feet off Whitestone Point.........	40 48 04	73 49 18	1	Ebb	21.0	24	4.68	85
75	1.38	500 feet off Whitestone Point.........	40 48 04	73 49 18	20	Ebb	21.0	24	5.00	91
76	1.40	500 feet off Whitestone Point.........	40 48 04	73 49 18	50	Ebb	21.0	24	5.00	91

7—EAST RIVER CROSS SECTION FROM COLLEGE POINT TO CLASON POINT.—JUNE 30, 1911

	P. M.									
77	2.20	200 feet off Clason Point dock........	40 48 15	73 51 11	1	Ebb	21.0	26	4.33	79
78	2.22	200 feet off Clason Point dock........	40 48 15	73 51 11	20	Ebb	21.0	24	4.33	79
79	2.24	200 feet off Clason Point dock........	40 48 15	73 51 11	40	Ebb	21.0	24	4.05	74
80	2.39	¼ way across from Clason Point......	40 48 09	73 51 11	1	Ebb	21.0	26	4.33	79
81	2.41	¼ way across from Clason Point......	40 48 09	73 51 11	20	Ebb	21.0	24	4.33	79
82	2.43	¼ way across from Clason Point......	40 48 09	73 51 11	40	Ebb	21.0	24	4.05	74
83	2.57	Midstream..........................	40 48 00	73 51 11	1	Ebb	21.0	26	4.33	79
84	2.59	Midstream..........................	40 48 00	73 51 11	20	Ebb	21.0	24	4.33	79
85	3.01	Midstream..........................	40 48 00	73 51 11	40	Ebb	21.0	24	4.05	74
86	3.16	¾ way across from Clason Point......	40 47 51	73 51 11	1	Ebb	21.0	26	4.33	79
87	3.18	¾ way across from Clason Point......	40 47 51	73 51 11	20	Ebb	21.0	24	4.33	79
88	3.20	¾ way across from Clason Point......	40 47 51	73 51 11	40	Ebb	21.0	24	4.05	74
89	3.35	300 feet off College Point............	40 47 44	73 51 11	1	Ebb	21.0	26	4.33	79
90	3.37	300 feet off College Point............	40 47 44	73 51 11	20	Ebb	21.0	24	4.33	79
91	3.40	300 feet off College Point............	40 47 44	73 51 11	35	Ebb	21.0	24	4.05	74

8—EAST RIVER FROM BATTERY TO LAWRENCE POINT. JULY 5, 1911

High water at Governor's Island at 4 P. M. Low water at 9.47 A. M. High water at Hell Gate at 5.50 P. M. Low water at 11.23 A. M.

	A. M.									
92	9.50	Midway between Governor's Island and Battery......................	40 41 50	74 00 56	1	Ebb	23.0	38	3.11	55
93	9.51	Midway between Governor's Island and Battery......................	40 41 50	74 00 56	20	Ebb	23.0	38	3.11	55
94	9.53	Midway between Governor's Island and Battery......................	40 41 50	74 00 56	30	Ebb	23.0	38	3.11	55
95	10.13	At Brooklyn Bridge, midstream.......	40 42 20	73 59 48	1	Ebb	23.0	38	2.96	53
96	10.14	At Brooklyn Bridge, midstream.......	40 42 20	73 59 48	20	Ebb	23.0	38	3.11	55
97	10.16	At Brooklyn Bridge, midstream.......	40 42 20	73 59 48	40	Ebb	23.0	38	3.11	55
98	10.36	At Williamsburg Bridge, midstream...	40 42 49	73 58 21	1	Ebb	23.0	38	2.96	53
99	10.37	At Williamsburg Bridge, midstream...	40 42 49	73 58 21	20	Ebb	23.0	38	3.11	55
100	10.40	At Williamsburg Bridge, midstream...	40 42 49	73 58 21	40	Ebb	23.0	36	3.11	55
101	11.00	At Queensboro Bridge, middle of East channel..........................	40 45 21	73 57 08	1	Ebb	23.0	36	3.11	55
102	11.01	At Queensboro Bridge, middle of East channel..........................	40 45 21	73 57 08	20	Ebb	23.0	36	3.11	55

TABLE XXVII—Continued

8—EAST RIVER FROM BATTERY TO LAWRENCE POINT. JULY 5, 1911—Continued

Sample No.	Hour A. M.	Location of Samples: Approximate	Location of Samples: Latitude	Location of Samples: Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen: C. C. per litre	Oxygen: Per cent. saturation
			° ′ ″	° ′ ″						
103	11.03	At Queensboro Bridge, middle of East channel	40 45 21	73 57 08	35	Ebb	23.0	36	3.11	55
104	11.20	Hell Gate, midway between Hallet's Point and Mill Rock	40 46 44	73 56 15	1	Ebb	23.0	32	3.11	57
105	11.21	Hell Gate, midway between Hallet's Point and Mill Rock	40 46 44	73 56 15	30	Ebb	23.0	32	3.11	57
106	11.23	Hell Gate, midway between Hallet's Point and Mill Rock	40 46 44	73 56 15	60	Ebb	23.0	32	3.11	57
107	11.40	Midway between Lawrence Point and Stony Point	40 47 35	73 54 40	1	Ebb	23.0	28	3.74	68
108	11.41	Midway between Lawrence Point and Stony Point	40 47 35	73 54 40	20	Ebb	23.0	28	4.05	74
109	11.43	Midway between Lawrence Point and Stony Point	40 47 35	73 54 40	50	Ebb	23.0	28	4.33	78
110	P. M. 3.00	Midway between Governor's Island (N. dock) and Battery Park (Barge office)	40 41 50	74 00 56	1	Flood	23.0	40	3.74	67
111	3.01	Midway between Governor's Island (N. dock) and Battery Park (Barge office)	40 41 50	74 00 56	20	Flood	23.0	36	3.74	67
112	3.03	Midway between Governor's Island (N. dock) and Battery Park (Barge office)	40 41 50	74 00 56	30	Flood	23.0	28	3.74	67
113	3.23	At Brooklyn Bridge, midstream	40 42 20	73 59 48	1	Flood	23.0	36	3.43	61
114	3.24	At Brooklyn Bridge, midstream	40 42 20	73 59 48	20	Flood	23.0	36	3.43	61
115	3.26	At Brooklyn Bridge, midstream	40 42 20	73 59 48	40	Flood	23.0	32	3.43	61
116	3.45	At Williamsburg Bridge, midstream	40 42 49	73 58 21	1	Flood	23.0	38	3.11	55
117	3.46	At Williamsburg Bridge, midstream	40 42 49	73 58 21	20	Flood	23.0	36	3.11	55
118	3.48	At Williamsburg Bridge, midstream	40 42 49	73 58 21	40	Flood	23.0	36	3.11	55
119	4.18	At Queensboro Bridge, midstream	40 45 21	73 57 08	1	Flood	23.0	40	3.11	55
120	4.19	At Queensboro Bridge, midstream	40 45 21	73 57 08	20	Flood	23.0	36	3.11	55
121	4.21	At Queensboro Bridge, midstream	40 45 21	73 57 08	35	Flood	23.0	36	3.11	55
122	4.40	Hell Gate midway between Hallet's Point and Mill Rock	40 46 44	73 56 15	1	Flood	23.0	40	3.11	55
123	4.41	Hell Gate midway between Hallet's Point and Mill Rock	40 46 44	73 56 15	30	Flood	23.0	36	3.11	55
124	4.43	Hell Gate midway between Hallet's Point and Mill Rock	40 46 44	73 56 15	60	Flood	23.0	36	3.11	55
125	5.03	Midway between Stony Point and Lawrence Point	40 47 35	73 54 40	1	Flood	23.0	36	3.11	55
126	5.04	Midway between Stony Point and Lawrence Point	40 47 35	73 54 40	20	Flood	23.0	36	3.11	55
127	5.06	Midway between Stony Point and Lawrence Point	40 47 35	73 54 40	50	Flood	23.0	36	3.11	55

9—GOWANUS CANAL. JULY 6, 1911

High water occurred at Governor's Island at 4.53 P. M. Low water at 10.27 A. M.

Sample No.	Hour	Location of Samples: Approximate	Location of Samples: Latitude	Location of Samples: Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen: C. C. per litre	Oxygen: Per cent. saturation
128	P. M. 2.30	Gowanus bay near anchorage buoy at outer end of bay	40 39 45	74 01 20	1	Flood	23.5	36	4.05	75
129	2.31	Gowanus bay near anchorage buoy at outer end of bay	40 39 45	74 01 20	15	Flood	23.5	36	4.05	75
130	2.33	Gowanus bay near anchorage buoy at outer end of bay	40 39 45	74 01 20	30	Flood	23.5	34	3.74	70
131	3.00	Gowanus canal at mouth, foot of 25th St.	40 39 55	74 00 25	1	Flood	24.0	36	3.11	57

TABLE XXVII—Continued

9—GOWANUS CANAL. JULY 6, 1911—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
132	3.04	Gowanus canal at mouth, foot of 25th st.	40 39 55	74 00 25	15	Flood	24.0	36	3.11	57
133	3.22	At Hamilton ave. bridge	40 40 17	73 59 56	1	Flood	24.5	36	2.33	43
134	3.25	At Hamilton ave. bridge	40 40 17	73 59 56	15	Flood	24.5	36	2.81	52
135	4.00	At 9th st. bridge	40 40 25	73 59 50	1	Flood	24.5	36	1.56	29
136	4.02	At 9th st. bridge	40 40 25	73 59 50	15	Flood	24.5	36	2.18	40

10—HUDSON RIVER-BATTERY TO YONKERS. JULY 7, 1911

High water occurred at Governor's Island at 5.23 P. M. Low water at 11.27 A. M.

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
137	A. M. 9.00	Midway between Pier A and C. R. R. of N. J. ferry, Jersey City	40 42 19	74 01 34	1	Ebb	24.5	46	3.43	63
138	9.01	Midway between Pier A and C. R. R. of N. J. ferry, Jersey City	40 42 19	74 01 34	20	Ebb	24.0	42	3.43	63
139	9.03	Midway between Pier A and C. R. R. of N. J. ferry, Jersey City	40 42 19	74 01 34	40	Ebb	24.0	34	3.43	63
140	9.20	Off Canal st., midstream	40 43 38	74 01 17	1	Ebb	24.5	54	3.43	63
141	9.21	Off Canal st., midstream	40 43 38	74 01 17	20	Ebb	24.0	48	3.43	62
142	9.23	Off Canal st., midstream	40 43 38	74 01 17	40	Ebb	24.0	40	3.43	62
143	9.40	Off 23d st., midstream	40 45 09	74 01 00	1	Ebb	25.0	60	3.27	58
144	9.41	Off 23d st., midstream	40 45 09	74 01 00	20	Ebb	24.5	52	3.11	55
145	9.43	Off 23d st., midstream	40 45 09	74 01 00	40	Ebb	24.0	44	3.11	57
146	10.00	Off W. 42d st., midstream	40 45 50	74 00 35	1	Ebb	25.0	66	3.11	54
147	10.01	Off W. 42d st., midstream	40 45 50	74 00 35	20	Ebb	24.5	52	3.43	62
148	10.03	Off W. 42d st., midstream	40 45 50	74 00 35	40	Ebb	24.0	44	3.74	69
149	10.23	Off W. 72d st., midstream	40 47 02	73 69 42	1	Ebb	25.0	70	4.05	70
150	10.24	Off W. 72d st., midstream	40 47 02	73 59 42	20	Ebb	24.5	56	4.05	73
151	10.26	Off W. 72d st., midstream	40 47 02	73 59 42	40	Ebb	24.0	52	4.05	75
152	10.46	Off W. 110th st., midstream	40 48 32	73 58 40	1	Ebb	25.0	78	5.27	91
153	10.47	Off W. 110th st., midstream	40 48 32	73 58 40	20	Ebb	24.5	60	4.05	72
154	10.49	Off W. 110th st., midstream	40 48 32	73 58 40	40	Ebb	24.0	52	4.05	73
155	11.11	Off W. 129th st., midstream	40 49 16	73 58 10	1	Ebb	25.0	84	5.27	91
156	11.12	Off W. 129th st., midstream	40 49 16	73 58 10	20	Ebb	24.5	68	4.05	72
157	11.14	Off W. 129th st., midstream	40 49 16	73 58 10	35	Ebb	24.5	62	4.05	72
158	11.34	Off W. 157th st., midstream	40 50 21	73 57 29	1	Ebb	25.0	84	5.27	91
159	11.35	Off W. 157th st., midstream	40 50 21	73 57 29	20	Ebb	24.5	72	3.74	67
160	11.37	Off W. 157th st., midstream	40 50 21	73 57 29	35	Ebb	24.0	63	3.74	67
161	11.57	Off Fort Washington point, midstream	40 51 04	73 57 13	1	Ebb	25.0	88	5.61	97
162	11.58	Off Fort Washington point, midstream	40 51 04	73 57 13	20	Ebb	24.5	72	3.74	67
163	12.00	Off Fort Washington point, midstream	40 51 04	73 57 13	35	Ebb	24.0	66	3.43	61
164	P. M. 12.20	Off Inwood, midstream	40 52 20	73 56 24	1	Ebb	25.0	88	5.61	97
165	12.21	Off Inwood, midstream	40 52 20	73 56 24	20	Ebb	24.5	76	3.74	67
166	12.23	Off Inwood, midstream	40 52 20	73 56 24	35	Ebb	24.0	68	3.43	61
167	12.43	Off Spuyten Duyvil, midstream	40 52 50	73 56 04	1	Ebb	25.0	88	5.61	97
168	12.44	Off Spuyten Duyvil, midstream	40 52 50	73 56 04	20	Ebb	24.5	76	4.33	77
169	12.46	Off Spuyten Duyvil, midstream	40 52 50	73 56 04	30	Ebb	24.5	70	4.05	72
170	1.06	Off Riverdale, midstream	40 54 10	73 55 25	1	Ebb	26.0	92	5.61	97
171	1.07	Off Riverdale, midstream	40 54 10	73 55 25	20	Ebb	25.0	76	4.67	83
172	1.09	Off Riverdale, midstream	40 54 10	73 55 25	30	Ebb	24.5	72	4.67	83
173	1.29	Off Mt. St. Vincent, midstream	40 54 50	73 55 15	1	Ebb	26.0	92	5.61	97
174	1.30	Off Mt. St. Vincent, midstream	40 54 50	73 55 15	20	Ebb	25.0	80	4.67	83

TABLE XXVII—Continued

10—HUDSON RIVER. JULY 7, 1911—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
175	1.32	Off Mt. St. Vincent, midstream	40 54 50	73 55 15	30	Ebb	24.5	76	4.67	83
176	1.52	Off Federal Sugar Refinery, Yonkers, midstream	40 55 47	73 54 53	1	Ebb	26.0	92	5.61	97
177	1.53	Off Federal Sugar Refinery, Yonkers, midstream	40 55 47	73 54 53	20	Ebb	25.0	76	4.67	83
178	1.55	Off Federal Sugar Refinery, Yonkers, midstream	40 55 47	73 54 53	30	Ebb	24.5	74	4.33	83
179	2.15	Off Power House, northern end of Yonkers, midstream	40 56 55	73 54 35	1	End of Ebb	26.0	94	5.76	99
180	2.16	Off Power House, northern end of Yonkers, midstream	40 56 55	73 54 35	20	End of Ebb	25.0	76	4.67	83
181	2.18	Off Power House, northern end of Yonkers, midstream	40 56 55	73 54 35	30	End of Ebb	24.5	74	4.67	83

11—HARLEM RIVER. JULY 10, 1911

High water at Governor's Island at 7.43 A. M. Low water at 1.27 P. M.
High water at Hell Gate at 9.30 A. M. Low water at 3.10 P. M.

	P. M.									
182	12.00	Off East 109th street, midstream	40 47 23	73 56 07	1	Ebb	23.5	34	1.50	28
183	12.01	Off East 109th street, midstream	40 47 23	73 56 07	15	Ebb	24.0	32	1.50	28
184	12.15	Willis Avenue Bridge, midstream	40 48 12	73 55 47	1	Ebb	23.5	32	1.87	35
185	12.16	Willis Avenue Bridge, midstream	40 48 12	73 55 47	15	Ebb	24.0	32	1.87	35
186	12.30	3d Avenue Bridge, midstream	40 48 25	73 55 58	1	Ebb	24.0	32	1.87	35
187	12.31	3d Avenue Bridge, midstream	40 48 25	73 55 58	15	Ebb	24.0	32	1.87	35
188	12.45	4th Avenue Bridge, midstream	40 48 36	73 56 02	1	Ebb	24.0	32	1.87	35
189	12.46	4th Avenue Bridge, midstream	40 48 36	73 56 02	15	Ebb	24.0	32	1.87	35
190	1.00	Madison Avenue Bridge, midstream	40 48 49	73 56 01	1	Ebb	24.0	32	1.87	35
191	1.01	Madison Avenue Bridge, midstream	40 48 49	73 56 01	15	Ebb	24.0	32	1.87	35
192	1.15	145th Street Bridge, midstream	40 49 10	73 56 00	1	Ebb	24.0	32	1.87	35
193	1.16	145th Street Bridge, midstream	40 49 10	73 56 00	15	Ebb	24.0	32	1.87	35
194	1.30	Central Bridge, midstream	40 49 40	73 56 03	1	Ebb	24.0	32	1.87	35
195	1.31	Central Bridge, midstream	40 49 40	73 56 03	15	Ebb	24.0	32	1.87	35
196	1.45	High Bridge, midstream	40 50 33	73 55 51	1	Ebb	24.0	32	2.18	40
197	1.46	High Bridge, midstream	40 50 33	73 55 51	15	Ebb	24.0	32	2.18	40
198	2.00	207th street Bridge, midstream	40 51 46	73 54 54	1	Ebb	24.0	32	2.49	46
199	2.01	207th Street Bridge, midstream	40 51 46	73 54 54	15	Ebb	24.0	32	2.49	46
200	2.15	Kingsbridge, midstream	40 52 25	73 54 39	1	Ebb	24.0	32	2.49	46
201	2.16	Kingsbridge, midstream	40 52 25	73 54 39	15	Ebb	24.0	32	2.49	46
202	2.30	100 feet east of Spuyten Duyvil Bridge	40 52 42	73 55 29	1	Ebb	24.0	34	2.80	52
203	2.31	100 feet east of Spuyten Duyvil Bridge	40 52 42	73 55 29	15	Ebb	24.0	34	2.80	52
204	3.00	100 feet east of Spuyten Duyvil Bridge	40 52 42	73 55 29	1	Flood	26.5	80	5.27	93
205	3.01	100 feet east of Spuyten Duyvil Bridge	40 52 42	73 55 29	15	Flood	26.0	76	5.27	93
206	3.15	Kingsbridge, midstream	40 52 25	73 54 39	1	Flood	26.0	72	4.33	80
207	3.16	Kingsbridge, midstream	40 52 25	73 54 39	15	Flood	26.0	72	4.33	80
208	3.30	207th Street Bridge, midstream	40 51 46	73 54 54	1	Flood	26.0	64	3.74	70
209	3.31	207th Street Bridge, midstream	40 51 46	73 54 54	15	Flood	25.5	64	3.74	70
210	3.45	Highbridge, midstream	40 50 33	73 55 51	1	Flood	25.5	56	3.43	64
211	3.46	Highbridge, midstream	40 50 33	73 55 51	15	Flood	25.5	56	3.43	64
212	4.00	Central Bridge, midstream	40 49 40	73 56 03	1	Flood	25.5	52	3.11	58
213	4.01	Central Bridge, midstream	40 49 40	73 56 03	15	Flood	25.5	52	3.11	58

TABLE XXVII—Continued

11—HARLEM RIVER. JULY 10, 1911—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. satura-tion
			° ′ ″	° ′ ″						
214	4.15	145th Street Bridge, midstream.......	40 49 10	73 56 00	1	Flood	25.5	44	2.80	53
215	4.16	145th Street Bridge, midstream.......	40 49 10	73 56 00	15	Flood	25.5	44	2.80	53
216	4.30	Madison Avenue Bridge, midstream...	40 48 49	73 56 01	1	Flood	25.5	40	2.49	47
217	4.31	Madison Avenue Bridge, midstream...	40 48 49	73 56 01	15	Flood	25.5	40	2.49	47
218	4.45	4th Avenue Bridge, midstream.......	40 48 36	73 56 02	1	Flood	25.5	40	2.18	41
219	4.46	4th Avenue Bridge, midstream.......	40 48 36	73 56 02	15	Flood	25.5	40	2.18	41
220	5.00	3d Avenue Bridge, midstream........	40 48 25	73 55 58	1	Flood	25.5	40	1.87	35
221	5.01	3d Avenue Bridge, midstream........	40 48 25	73 55 58	15	Flood	25.5	40	1.87	35
222	5.15	Willis Avenue Bridge, midstream.....	40 48 12	73 55 47	1	Flood	25.5	36	1.50	29
223	5.16	Willis Avenue Bridge, midstream.....	40 48 12	73 55 47	15	Flood	25.5	36	1.50	29
224	5.30	Foot of East 109th street, midstream .	40 47 23	73 56 07	1	Flood	25.5	34	1.24	24
225	5.31	Foot of East 109th street, midstream .	40 47 23	73 56 07	15	Flood	25.5	34	1.24	24

12—BUTTERMILK CHANNEL. JULY 11, 1911

High water at Governor's Island at 8.13 A. M. Low water at 2.06 P. M.

	A. M.									
226	9.50	Inner end of slip foot of Degraw street, Brooklyn........................	40 41 13	74 00 25	1	Ebb	26.0	38	0.31	6
227	9.52	Inner end of slip foot of Degraw street, Brooklyn........................	40 41 13	74 00 25	10	Ebb	25.5	34	0.31	6
228	10.07	Outer end of Degraw street slip	40 41 14	74 00 29	1	Ebb	25.5	38	0.62	12
229	10.09	Outer end of Degraw street slip	40 41 14	74 00 29	20	Ebb	25.5	34	1.87	36
230	10.29	100 feet off outer end of Degraw street slip...........................	40 41 14	74 00 31	1	Ebb	25.5	36	0.93	18
231	10.30	100 feet off outer end of Degraw street slip...........................	40 41 14	74 00 31	20	Ebb	25.5	34	2.80	54
232	10.31	100 feet off outer end of Degraw street slip...........................	40 41 14	74 00 31	30	Ebb	25.5	34	3.11	60
233	10.50	200 feet off outer end of Degraw street slip...........................	40 41 15	74 00 32	1	Ebb	25.5	36	3.11	60
234	10.51	200 feet off outer end of Degraw street slip...........................	40 41 15	74 00 32	20	Ebb	25.5	36	3.11	60
235	10.53	200 feet off outer end of Degraw street slip...........................	40 41 15	74 00 32	35	Ebb	25.5	34	3.11	60
236	11.12	Inner end of slip east of Pier 32.......	40 41 14	74 00 23	1	Ebb	26.0	36	0.31	6
237	11.14	Inner end of slip east of Pier 32.......	40 41 14	74 00 23	10	Ebb	25.5	34	0.93	18
238	11.19	Outer end of slip east of Pier 32......	40 41 16	74 00 28	1	Ebb	26.0	36	0.62	12
239	11.20	Outer end of slip east of Pier 32......	40 41 16	74 00 28	15	Ebb	25.5	34	1.87	36
240	11.35	200 feet off Pier 29...................	40 41 22	74 00 26	1	Ebb	25.5	34	3.11	60
241	11.37	200 feet off Pier 29...................	40 41 22	74 00 26	20	Ebb	25.5	34	3.43	66
242	11.39	200 feet off Pier 29...................	40 41 22	74 00 26	35	Ebb	25.5	34	3.43	66
243	11.50	Outer end of slip west of Pier 29......	40 41 19	74 00 25	1	Ebb	26.0	34	2.49	50
244	11.51	Outer end of slip west of Pier 29......	40 41 19	74 00 25	20	Ebb	25.5	34	2.49	50
	P. M.									
245	12.06	Inner end of slip west of Pier 29......	40 41 18	74 00 18	1	Ebb	26.0	36	1.50	30
246	12.08	Inner end of slip west of Pier 29......	40 41 18	74 00 18	10	Ebb	26.0	34	1.87	36
247	12.23	100 feet off east end of Pier 33........	40 41 10	74 00 34	1	Ebb	25.5	34	2.18	40
248	12.24	100 feet off east end of Pier 33........	40 41 10	74 00 34	20	Ebb	25.5	34	2.80	54
249	12.26	100 feet off east end of Pier 33........	40 41 10	74 00 34	30	Ebb	25.5	34	2.80	54
250	12.45	200 feet off east end of Pier 33........	40 41 11	74 00 35	1	Ebb	25.5	34	3.11	60
251	12.46	200 feet off east end of Pier 33........	40 41 11	74 00 35	20	Ebb	25.5	34	3.11	60
252	12.48	200 feet off east end of Pier 33........	40 41 11	74 00 35	35	Ebb	25.5	34	3.11	60
253	1.18	200 feet off west end of Pier 33.......	40 41 04	74 00 46	1	Ebb	35.5	24	3.11	60

TABLE XXVII—Continued

12—BUTTERMILK CHANNEL. JULY 11, 1911—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
254	1.19	200 feet off west end of Pier 33	40 41 04	74 00 46	20	Ebb	25.5	34	3.43	66
255	1.21	200 feet off west end of Pier 33	40 41 04	74 00 46	35	Ebb	25.5	34	3.43	66
256	1.40	Entrance to Atlantic Basin	40 41 01	74 00 45	1	Ebb	25.5	34	2.18	40
257	1.42	Entrance to Atlantic Basin	40 41 01	74 00 45	20	Ebb	25.5	34	2.49	50
258	1.57	South side of Atlantic Basin, Bowne street	40 40 59	74 00 33	1	Ebb	26.0	34	1.24	24
259	1.58	South side of Atlantic Basin, Bowne street	40 40 59	74 00 33	15	Ebb	26.0	34	1.24	24
260	2.15	Upper bay, 400 feet off Pier 39	40 40 42	74 01 18	1	Ebb	25.5	34	2.80	54
261	2.16	Upper bay, 400 feet off Pier 39	40 40 42	74 01 18	30	Ebb	25.5	34	3.43	66
262	2.30	Upper bay, 600 feet off Pier 39	40 40 42	74 01 20	1	Ebb	25.5	34	3.43	66
263	2.30	Upper bay, 600 feet off Pier 39	40 40 42	74 01 20	30	Ebb	25.5	34	3.43	66
264	2.45	Upper bay, 400 feet off Erie Basin entrance	40 40 19	74 01 15	1	Ebb	25.5	34	3.11	60
265	2.46	Upper bay, 400 feet off Erie Basin entrance	40 40 19	74 01 15	30	Ebb	25.5	34	3.43	66
266	3.00	Upper bay, 600 feet off Erie Basin entrance	40 40 19	74 01 17	1	Ebb	25.5	34	3.43	66
267	3.01	Upper bay, 600 feet off Erie Basin entrance	40 40 19	74 01 17	30	Ebb	25.5	34	3.43	66
268	3.15	Upper bay, 500 feet off 53d street, Brooklyn	40 39 10	74 01 37	1	Ebb	25.5	34	3.43	66
269	3.16	Upper bay, 500 feet off 53d street, Brooklyn	40 39 10	74 01 37	30	Ebb	25.5	34	3.43	66
270	3.30	Gowanus bay, near anchorage buoy	40 39 45	74 01 20	1	Flood	25.5	34	3.43	66
271	3.31	Gowanus bay, near anchorage buoy	40 39 45	74 01 20	30	Flood	25.5	34	3.43	66

13—HUDSON RIVER. JULY 12, 1911

High water occurred at Governor's Island at 8.53 A. M. Low water occurred at 2.47 P. M.

	A. M.									
272	9.30	East river, midway between Battery and Governor's Island	40 41 52	74 00 59	1	Flood	24.5	32	3.11	59
273	9.31	East river, midway between Battery and Governor's Island	40 41 52	74 00 59	20	Flood	24.5	32	3.43	65
274	9.33	East river, midway between Battery and Governor's Island	40 41 52	74 00 59	35	Flood	24.5	32	3.43	65
275	10.00	Hudson river, midway between Pier A and C. R.R. of N. J.	40 42 19	74 01 34	1	Flood	24.5	32	3.43	63
276	10.01	Midway between Pier A and C. R.R. of N. J.	40 42 19	74 01 34	20	Flood	24.5	32	3.43	65
277	10.03	Midway between Pier A and C. R.R. of N. J.	40 42 19	74 01 34	40	Flood	24.5	32	3.43	65
278	11.00	Midway between Pier A and C. R.R. of N. J.	40 42 19	74 01 34	1	Ebb	25.5	40	3.43	65
279	11.01	Midway between Pier A and C. R.R. of N. J.	40 42 19	74 01 34	20	Ebb	25.0	32	3.43	66
280	11.03	Midway between Pier A and C. R.R. of N. J.	40 42 19	74 01 34	40	Ebb	25.0	32	3.43	66
281	11.20	Off Canal street, midstream	40 43 38	74 01 17	1	Ebb	25.5	44	3.43	65
282	11.21	Off Canal street, midstream	40 43 38	74 01 17	20	Ebb	25.0	46	3.43	66
283	11.23	Off Canal street, midstream	40 43 38	74 01 17	40	Ebb	25.0	46	3.43	66
284	11.40	Off West 23d street, midstream	40 45 09	74 01 00	1	Ebb	25.5	48	3.43	65
285	11.41	Off West 23d street, midstream	40 45 09	74 01 00	20	Ebb	25.0	36	3.43	66
286	11.43	Off West 23d street, midstream	40 45 09	74 01 00	40	Ebb	25.0	36	3.43	66
287	12.00	Off West 42d street, midstream	40 45 50	74 00 35	1	Ebb	25.5	52	3.74	69

TABLE XXVII—Continued

13—HUDSON RIVER. JULY 12, 1911—Continued

Sample No.	Hour P. M.	Location of Samples: Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen: C. C. per litre	Oxygen: Per cent. saturation
			° ′ ″	° ′ ″						
288	12.01	Off West 42d street, midstream	40 45 50	74 00 35	20	Ebb	25.0	40	3.43	65
289	12.03	Off West 42d street, midstream	40 45 50	74 00 35	40	Ebb	25.0	40	3.43	65
290	12.20	Off West 72d street, midstream	40 47 02	73 59 42	1	Ebb	25.5	52	4.05	75
291	12.21	Off West 72d street, midstream	40 47 02	73 59 42	20	Ebb	25.0	40	3.74	70
292	12.23	Off West 72d street, midstream	40 47 02	73 59 42	40	Ebb	25.0	40	3.74	70
293	12.40	Off West 110th street, midstream	40 48 32	73 58 40	1	Ebb	25.5	56	4.67	86
294	12.41	Off West 110th street, midstream	40 48 32	73 58 40	20	Ebb	25.0	44	3.74	70
295	12.43	Off West 110th street, midstream	40 48 32	73 58 40	40	Ebb	25.0	44	3.74	70
296	1.00	Off West 129th street, midstream	40 49 16	73 58 10	1	Ebb	25.5	64	5.27	96
297	1.01	Off West 129th street, midstream	40 49 16	73 58 10	20	Ebb	25.0	48	4.05	75
298	1.03	Off West 129th street, midstream	40 49 16	73 58 10	35	Ebb	25.0	48	4.05	75
299	1.20	Off West 157th street, midstream	40 50 21	73 57 29	1	Ebb	25.5	64	5.27	96
300	1.21	Off West 157th street, midstream	40 50 21	73 57 29	20	Ebb	25.0	48	4.05	75
301	1.23	Off West 157th street, midstream	40 50 21	73 57 29	35	Ebb	25.0	48	4.05	75
302	1.40	Off Fort Washington Point, midstream	40 51 04	73 57 13	1	Ebb	26.0	68	5.61	100
303	1.41	Off Fort Washington Point, midstream	40 51 04	73 57 13	20	Ebb	25.0	48	4.05	75
304	1.43	Off Fort Washington Point, midstream	40 51 04	73 57 13	35	Ebb	25.0	48	4.05	75
305	2.00	Off Inwood, midstream	40 52 20	73 56 24	1	Ebb	26.0	68	5.61	100
306	2.01	Off Inwood, midstream	40 52 20	73 56 24	20	Ebb	25.0	52	4.05	75
307	2.03	Off Inwood, midstream	40 52 20	73 56 24	35	Ebb	25.0	52	4.05	75
308	2.20	Off Spuyten Duyvil, midstream	40 52 50	73 56 04	1	Ebb	26.0	80	5.61	100
309	2.21	Off Spuyten Duyvil, midstream	40 52 50	73 56 04	20	Ebb	25.5	56	4.05	75
310	2.23	Off Spuyten Duyvil, midstream	40 52 50	73 56 04	30	Ebb	25.5	56	4.05	75
311	2.40	Off Riverdale, midstream	40 54 10	73 55 25	1	Ebb	26.0	80	5.61	100
312	2.41	Off Riverdale, midstream	40 54 10	73 55 25	20	Ebb	25.5	60	4.33	80
313	2.43	Off Riverdale, midstream	40 54 10	73 55 25	30	Ebb	25.5	60	4.33	80
314	3.00	Off Mt. St. Vincent, midstream	40 54 50	73 55 15	1	Ebb	26.0	80	5.61	100
315	3.01	Off Mt. St. Vincent, midstream	40 54 50	73 55 15	20	Ebb	25.5	64	4.33	80
316	3.03	Off Mt. St. Vincent, midstream	40 54 50	73 55 15	30	Ebb	25.5	64	4.33	80
317	3.20	Off Federal Sugar Refinery, Yonkers, midstream	40 55 47	73 54 53	1	Ebb	26.0	80	5.61	100
318	3.21	Off Federal Sugar Refinery, Yonkers, midstream	40 55 47	73 54 53	20	Ebb	25.5	64	4.33	80
319	3.23	Off Federal Sugar Refinery, Yonkers, midstream	40 55 47	73 54 53	30	Ebb	25.5	64	4.33	80
320	3.40	Off power house, upper end of Yonkers, midstream	40 56 55	73 54 35	1	Ebb	26.0	84	5.61	100
321	3.41	Off power house, upper end of Yonkers, midstream	40 56 55	73 54 35	20	Ebb	25.5	64	4.33	80
322	3.43	Off power house, upper end of Yonkers, midstream	40 56 55	73 54 35	30	Ebb	25.5	64	4.33	80

14—BUTTERMILK CHANNEL. JULY 13, 1911

High water occurred at Governor's Island at 9.23 A. M. Low water occurred at 3.02 P. M.

	A. M.									
323	9.20	200 feet off outer end of Degraw street slip	40 41 15	74 00 32	1	Flood	25.5	32	3.11	60
324	9.21	200 feet off outer end of Degraw street slip	40 41 15	74 00 32	20	Flood	25.0	32	3.11	60
325	9.23	200 feet off outer end of Degraw street slip	40 41 15	74 00 32	35	Flood	25.0	32	3.11	60
326	9.28	50 feet off outer end of Degraw street slip	40 41 14	74 00 30	1	Flood	25.5	34	1.24	24

TABLE XXVII—Continued

14—BUTTERMILK CHANNEL. JULY 13, 1911—Continued

Sample No.	Hour A. M.	Location of Samples: Approximate	Location of Samples: Latitude	Location of Samples: Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen: C. C. per litre	Oxygen: Per cent. saturation
			° ′ ″	° ′ ″						
327	9.29	50 feet off outer end of Degraw street slip	40 41 14	74 00 30	20	Flood	25.0	32	2.80	56
328	9.31	50 feet off outer end of Degraw street slip	40 41 14	74 00 30	30	Flood	25.0	32	3.11	60
329	9.46	Degraw street slip, outer end	40 41 14	74 00 29	1	Flood	26.0	34	0.93	18
330	9.48	Degraw street slip, outer end	40 41 14	74 00 29	20	Flood	25.5	34	2.18	42
331	10.02	Degraw street slip, inner end	40 41 13	74 00 25	1	Flood	26.0	34	0.47	9
332	10.04	Degraw street slip, inner end	40 41 13	74 00 25	10	Flood	26.0	34	0.62	12
333	10.20	200 feet off Pier 29	40 41 22	74 00 26	1	Flood	25.5	34	3.11	60
334	10.21	200 feet off Pier 29	40 41 22	74 00 26	20	Flood	25.0	32	3.11	60
335	10.23	200 feet off Pier 29	40 41 22	74 00 26	30	Flood	25.0	32	3.11	60
336	10.40	50 feet off Pier 29, Brooklyn	40 41 21	74 00 25	1	Flood	25.5	34	2.49	48
337	10.42	50 feet off Pier 29, Brooklyn	40 41 21	74 00 25	30	Flood	25.0	32	3.11	60
338	10.57	Slip just west of Pier 29, midway up slip	40 41 18	74 00 21	1	Flood	25.5	34	1.50	30
339	10.58	Slip just west of Pier 29, midway up slip	40 41 18	74 00 21	15	Flood	25.0	32	1.50	30
340	11.10	200 feet off east end of Pier 33	40 41 11	74 00 35	1	Flood	25.5	34	3.74	72
341	11.11	200 feet off east end of Pier 33	40 41 11	74 00 35	20	Flood	25.0	32	3.74	72
342	11.13	200 feet off east end of Pier 33	40 41 11	74 00 35	35	Flood	25.0	32	3.74	72
343	11.30	50 feet off east end of Pier 33	40 41 10	74 00 33	1	Flood	25.5	34	3.74	72
344	11.31	50 feet off east end of Pier 33	40 41 10	74 00 33	20	Flood	25.0	32	3.74	72
345	11.33	50 feet off east end of Pier 33	40 41 10	74 00 33	35	Flood	25.0	32	3.74	72
346	11.48	Entrance to Atlantic Basin	40 41 01	74 00 45	1	Ebb	25.5	34	3.74	72
347	11.50	South extremity of Atlantic Basin, Bowne street	40 40 59	74 00 33	1	Ebb	25.5	34	1.24	24
348	11.51	South extremity of Atlantic Basin, Bowne street	40 40 59	74 00 33	10	Ebb	25.5	34	1.24	24

15—COURSE FROM GOVERNOR'S ISLAND TO ATLANTIC OCEAN. JULY 13, 1911

High water occurred at Governor's Island at 10.23 A. M. Low water at 4.27 P. M.
High water occurred at Sandy Hook at 8.50 A. M. Low water at 2.30 P. M.

Sample No.	Hour P. M.	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
349	12.00	East river, midway between Governor's Island and Pier 38, Brooklyn	40 40 53	74 01 19	1	Ebb	24.0	32	3.11	59
350	12.01	East river, midway between Governor's Island and Pier 38, Brooklyn	40 40 53	74 01 19	20	Ebb	24.0	32	3.11	59
351	12.03	East river, midway between Governor's Island and Pier 38, Brooklyn	40 40 53	74 01 19	35	Ebb	24.0	32	3.11	59
352	12.20	Upper bay, near nun buoy 14 off Gowanus	40 40 04	74 02 09	1	Ebb	24.5	32	3.11	59
353	12.21	Upper bay, near nun buoy 14 off Gowanus	40 40 04	74 02 09	20	Ebb	24.0	30	3.11	59
354	12.23	Upper bay, near nun buoy 14 off Gowanus	40 40 04	74 02 09	30	Ebb	24.0	30	3.11	59
355	12.44	Upper bay, near Robbin's Reef bell buoy	40 39 15	74 03 50	1	Ebb	24.5	34	3.43	65
356	12.45	Upper bay, near Robbin's Reef bell buoy	40 39 15	74 03 50	20	Ebb	24.0	32	3.43	65
357	12.47	Upper bay, near Robbin's Reef bell buoy	40 39 15	74 03 50	40	Ebb	24.0	28	3.43	65
358	1.07	Narrows, midway between forts	40 36 25	74 02 48	1	Ebb	23.0	26	3.43	66
359	1.09	Narrows, midway between forts	40 36 25	74 02 48	40	Ebb	22.0	20	3.43	64
360	1.12	Narrows, midway between forts	40 36 25	74 02 48	80	Ebb	22.0	20	3.43	64

TABLE XXVII—Continued

15—COURSE FROM GOVERNOR'S ISLAND TO ATLANTIC OCEAN. JULY 13, 1911—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
361	1.32	Lower bay by Craven shoal buoy.....	40 35 10	74 02 30	1	Ebb	23.0	24	3.74	70
362	1.33	Lower bay by Craven shoal buoy.....	40 35 10	74 02 30	20	Ebb	21.5	20	3.74	70
363	1.35	Lower bay by Craven shoal buoy.....	40 35 10	74 02 30	40	Ebb	21.5	20	3.74	70
364	2.00	Lower bay Ambrose channel buoy 19..	40 32 20	74 01 15	1	Ebb	23.0	24	5.27	99
365	2.01	Lower bay Ambrose channel buoy 19..	40 32 20	74 01 15	20	Ebb	21.5	20	5.27	99
366	2.03	Lower bay Ambrose channel buoy 19..	40 32 20	74 01 15	40	Ebb	21.5	20	5.27	99
367	2.30	Lower bay Ambrose channel buoy 6...	40 30 25	73 57 35	1	Ebb	21.0	20	5.61	100
368	2.31	Lower bay Ambrose channel buoy 6...	40 30 25	73 57 35	20	Ebb	20.0	12	5.61	100
369	2.33	Lower bay Ambrose channel buoy 6...	40 30 25	73 57 35	40	Ebb	20.0	12	5.61	100
370	3.00	Atlantic ocean, east of whistling buoy outside Ambrose channel..........	40 29 00	73 53 00	1	Ebb	21.0	18	5.61	100
371	3.01	Atlantic ocean, east of whistling buoy outside Ambrose channel..........	40 29 00	73 53 00	25	Ebb	20.0	12	5.61	100
372	3.03	Atlantic ocean, east of whistling buoy outside Ambrose channel..........	40 29 00	73 53 00	50	Ebb	20.0	12	5.61	100

16—COURSE FROM GOVERNOR'S ISLAND TO ATLANTIC OCEAN. JULY 14, 1911

High water occurred at Governor's Island at 9.33 A. M. Low water at 4.07 P. M.
High water occurred at Sandy Hook at 9.23 A. M. Low water at 3.15 P. M.

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
	A. M.									
373	8.00	East river, midway between Governor's Island and Pier 38, Brooklyn.......	40 40 53	74 01 19	1	Flood	23.0	30	3.43	62
374	8.01	East river, midway between Governor's Island and Pier 38, Brooklyn.......	40 40 53	74 01 19	20	Flood	22.0	28	3.43	62
375	8.03	East river, midway between Governor's Island and Pier 38, Brooklyn.......	40 40 53	74 01 19	35	Flood	22.0	28	3.43	62
376	8.20	Upper Bay, near nun buoy 14 off Gowanus..........................	40 40 04	74 02 09	09	Flood	23.0	30	3.43	62
377	8.21	Upper bay, near nun buoy 14 off Gowanus..........................	40 40 04	74 02 09	20	Flood	22.0	28	3.43	62
378	8.23	Upper bay, near nun buoy 14 off Gowanus..........................	40 40 04	74 02 09	30	Flood	22.0	28	3.43	62
379	8.40	Upper bay, near Robbin's Reef bell buoy..........................	40 39 15	74 03 50	1	Flood	23.0	30	3.74	68
380	8.41	Upper bay, near Robbin's Reef bell buoy..........................	40 39 15	74 03 50	20	Flood	21.5	26	4.05	74
381	8.43	Upper bay, near Robbin's Reef bell buoy..........................	40 39 15	74 03 50	40	Flood	21.5	24	4.05	74
382	9.15	Narrows, midway between forts......	40 36 25	74 02 48	1	Flood	22.0	26	4.33	79
383	9.16	Narrows, midway between forts......	40 36 25	74 02 48	40	Flood	21.5	24	4.67	85
384	9.18	Narrows, midway between forts......	40 36 25	74 02 48	80	Flood	21.5	24	4.67	85
385	9.26	Lower bay, near Craven shoal buoy...	40 35 10	74 02 30	1	Flood	22.0	24	5.01	93
386	9.27	Lower bay, near Craven shoal buoy...	40 35 10	74 02 30	20	Flood	21.5	22	5.01	93
387	9.29	Lower bay, near Craven shoal buoy...	40 35 10	74 02 30	40	Flood	21.5	22	5.01	93
388	9.50	Lower bay, near Ambrose channel buoy	40 33 30	74 01 35	1	Flood	20.0	16	5.61	97
389	9.51	Lower bay, near Ambrose channel buoy	40 33 30	74 01 35	20	Flood	19	12	5.61	100
390	9.53	Lower bay, near Ambrose channel buoy	40 33 30	74 01 35	40	Flood	19	12	5.61	100
391	10.20	Lower bay, near Ambrose channel buoy	40 32 20	74 01 15	1	Flood	20	16	5.76	100
392	10.21	Lower bay, near Ambrose channel buoy	40 32 20	74 01 15	20	Flood	18.5	12	5.61	100
393	10.23	Lower bay, near Ambrose channel buoy	40 32 20	74 01 15	40	Flood	18.5	12	5.61	100
394	10.45	Lower bay, near Ambrose channel buoy	40 30 25	73 57 35	1	Flood	17.0	12	5.76	100
395	10.46	Lower bay, near Ambrose channel buoy	40 30 25	73 57 35	20	Flood	16.0	8	5.76	100
396	10.48	Lower bay, near Ambrose channel buoy	40 30 25	73 57 35	40	Flood	16.0	8	5.76	100

TABLE XXVII—Continued

16—COURSE FROM GOVERNOR'S ISLAND TO ATLANTIC OCEAN. JULY 14, 1911—Continued

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
397	11.20	Atlantic ocean, midway between Ambrose channel buoy 2 and whistling buoy farther out	40 28 20	73 51 40	1	End of Flood	17.0	10	5.76	100
398	11.20	Atlantic Ocean, midway between Ambrose channel buoy 2 and whistling buoy farther out	40 28 20	73 51 40	20	End of Flood	16.0	8	5.76	100
399	11.23	Atlantic ocean, midway between Ambrose channel buoy 2 and whistling buoy farther out	40 28 20	73 51 40	40	End of Flood	15.5	8	5.76	100

17—KILL VAN KULL. JULY 17, 1911

High water occurred at Governor's Island at 12.08 A. M. Low water at 6.27 P. M.

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
400	A. M. 10.40	Upper New York bay, near Robbin's Reef bell buoy	40 39 15	74 03 50	1	Flood	23.0	30	3.74	68
401	10.41	Upper New York bay, near Robbin's Reef bell buoy	40 39 15	74 03 50	20	Flood	22.0	24	3.74	68
402	10.43	Upper New York bay, near Robbin's Reef bell buoy	40 39 15	74 03 50	40	Flood	22.0	24	3.74	68
403	11.00	Kill van Kull off Jersey street, New Brighton, S. I., midstream	40 38 57	74 05 25	1	Flood	23.0	32	3.43	62
404	11.01	Kill van Kull off Jersey street, New Brighton, S. I., midstream	40 38 57	74 05 25	20	Flood	22.0	24	3.74	68
405	11.03	Kill van Kull off Jersey street, New Brighton, S. I., midstream	40 38 57	74 05 25	40	Flood	22.0	24	3.74	68
406	11.20	Kill van Kull off Sailors' Snug Harbor, midstream	40 38 50	74 06 07	1	Flood	23.0	32	3.43	62
407	11.21	Kill van Kull off Sailors' Snug Harbor, midstream	40 38 50	74 06 07	20	Flood	22.0	28	3.74	68
408	11.23	Kill van Kull off Sailors' Snug Harbor, midstream	40 38 50	74 06 07	35	Flood	22.0	28	3.74	68
409	11.40	Kill van Kull off Port Richmond ferry, midstream	40 38 35	74 07 52	1	Flood	23.0	32	3.43	62
410	11.41	Kill van Kull off Port Richmond ferry, midstream	40 38 35	74 07 52	20	Flood	22.0	28	3.74	68
411	11.43	Kill van Kull off Port Richmond ferry, midstream	40 38 35	74 07 52	40	Flood	22.0	28	3.74	68
412	12.00	Kill van Kull at buoy S. 2 off Bergen Point, midstream	40 38 35	74 08 24	1	Flood	23.0	32	3.43	62
413	P. M. 12.01	Kill van Kull at buoy S. 2 off Bergen Point, midstream	40 38 35	74 08 24	20	Flood	22.0	30	3.43	62
414	12.03	Kill van Kull at buoy S. 2 off Bergen Point, midstream	40 38 35	74 08 24	40	Flood	22.0	30	3.43	62
415	12.20	Kill van Kull, 100 feet south of Bergen Point light	40 38 32	74 08 56	1	Flood	23.0	32	3.43	62
416	12.21	Kill van Kull, 100 feet south of Bergen Point light	40 38 32	74 08 56	20	Flood	22.0	30	3.43	62
417	12.23	Kill van Kull, 100 feet south of Bergen Point light	40 38 32	74 08 56	30	Flood	22.0	30	3.43	62

TABLE XXVII—Continued

18—EAST RIVER, CROSS-SECTION, LAWRENCE POINT TO STONY POINT. JULY 18, 1911

High water occurred at Governor's Island at 12.53 P. M. Low water at 7.17 A. M.
High water occurred at Hell Gate at 3.30 P. M. Low water at 9.00 A. M.

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
418	10.10	By buoy 7, near Lawrence Point, Astoria	40 47 34	73 54 30	1	Flood	21.5	24	3.24	59
419	10.11	By buoy 7, near Lawrence Point, Astoria	40 47 34	73 54 30	20	Flood	21.0	24	3.24	59
420	10.13	By buoy 7, near Lawrence Point, Astoria	40 47 34	73 54 30	40	Flood	21.0	24	3.24	59
421	10.23	Midway between Lawrence Point and Stony Point	40 47 45	73 54 31	1	Flood	21.5	24	3.24	59
422	10.24	Midway between Lawrence Point and Stony Point	40 47 45	73 54 31	25	Flood	21.0	24	3.24	59
423	10.26	Midway between Lawrence Point and Stony Point	40 47 45	73 54 31	50	Flood	21.0	24	3.24	59
424	10.45	200 feet off East 134th street ferry house at Stony Point	40 47 56	73 54 31	1	Flood	21.5	24	3.24	59
425	10.46	200 feet off East 134th street ferry house at Stony Point	40 47 56	73 54 31	25	Flood	21.0	24	3.24	59
426	10.48	200 feet off East 134th street ferry house at Stony Point	40 47 56	73 54 31	50	Flood	21.0	24	3.24	59
427	11.30	By buoy 7, near Lawrence Point	40 47 34	73 54 30	1	Flood	21.5	28	3.09	56
428	11.31	By buoy 7, near Lawrence Point	40 47 34	73 54 30	20	Flood	21.0	26	3.09	56
429	11.33	By buoy 7, near Lawrence Point	40 47 34	73 54 30	40	Flood	21.0	26	3.09	56
430	11.53	Midway between Lawrence and Stony Points	40 47 45	73 54 31	1	Flood	21.5	28	3.09	56
431	11.54	Midway between Lawrence and Stony Points	40 47 45	73 54 31	25	Flood	21.0	26	3.09	56
432	11.56	Midway between Lawrence and Stony Points	40 47 45	73 54 31	50	Flood	21.0	26	3.09	56
433	P. M. 12.17	200 feet off East 134th street ferry house	40 47 56	73 54 31	1	Flood	21.5	28	3.09	56
434	12.18	200 feet off East 134th street ferry house	40 47 56	73 54 31	25	Flood	21.0	26	3.09	56
435	12.20	200 feet off East 134th street ferry house	40 47 56	73 54 31	50	Flood	21.0	26	3.24	59
436	1.00	By buoy 7, near Lawrence Point	40 47 34	73 54 30	1	Flood	21.5	30	2.95	54
437	1.01	By buoy 7, near Lawrence Point	40 47 34	73 54 30	20	Flood	21.0	28	2.95	54
438	1.03	By buoy 7, near Lawrence Point	40 47 34	73 54 30	40	Flood	21.0	28	2.95	54
439	1.23	Midway between Lawrence and Stony Points	40 47 45	73 54 31	1	Flood	21.5	30	2.95	54
440	1.24	Midway between Lawrence and Stony Points	40 47 45	73 54 31	25	Flood	21.0	28	2.95	54
441	1.26	Midway between Lawrence and Stony Points	40 47 45	73 54 31	50	Flood	21.0	28	3.09	56
442	1.46	200 feet off East 134th street ferry house	40 47 56	73 54 31	1	Flood	21.5	30	2.95	54
443	1.47	200 feet off East 134th street ferry house	40 47 56	73 54 31	25	Flood	21.0	28	2.95	54
444	1.49	200 feet off East 134th street ferry house	40 47 5	73 54 31	50	Flood	21.0	28	3.09	56
445	2.30	By buoy 7 near Lawrence Point	40 47 34	73 54 30	1	Flood	21.5	30	2.95	54
446	2.31	By buoy 7 near Lawrence Point	40 47 34	73 54 30	20	Flood	21.0	28	2.95	54
447	2.33	By buoy 7 near Lawrence Point	40 47 34	73 54 30	40	Flood	21.0	28	2.95	54
448	2.50	Midway between Lawrence Point and Stony Point	40 47 45	73 54 31	1	Flood	21.5	30	2.95	54
449	2.51	Midway between Lawrence Point and Stony Point	40 47 45	73 54 31	25	Flood	21.0	28	2.95	54

TABLE XXVII—Continued

18—EAST RIVER, CROSS-SECTION LAWRENCE POINT TO STONY POINT. JULY 18, 1911—Continued.

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
450	2.53	Midway between Lawrence and Stony Points	40 47 45	73 54 31	50	Flood	21.0	28	2.95	54
451	3.10	200 feet off East 134th street ferry house	40 47 56	73 54 31	1	Flood	21.5	30	2.95	54
452	3.11	200 feet off East 134th street ferry house	40 47 56	73 54 31	25	Flood	21.0	28	2.95	54
453	3.13	200 feet off East 134th street ferry house	40 47 56	73 54 31	50	Flood	21.0	28	2.95	54
454	3.30	By buoy 7 near Lawrence Point	40 47 34	73 54 30	1	Flood	21.5	30	2.95	54
455	3.31	By buoy 7 near Lawrence Point	40 47 34	73 54 30	20	Flood	21.0	28	2. 5	54
456	3.33	By buoy 7 near Lawrence Point	40 47 34	73 54 30	40	Flood	21.0	28	2.95	54
457	3.45	Midway between Lawrence and Stony Points	40 47 45	73 54 31	1	Flood	21.5	30	2.95	54
458	3.46	Midway between Lawrence and Stony Points	40 47 45	73 54 31	25	Flood	21.0	28	2.95	54
459	3.48	Midway between Lawrence and Stony Points	40 47 45	73 54 31	50	Flood	21.0	28	2.95	54
460	4.00	200 feet off East 134th street ferry house	40 47 56	73 54 31	1	Flood	21.5	30	2.95	54
461	4.01	200 feet off East 134th street ferry house	40 47 56	73 54 31	25	Flood	21.0	26	3.09	56
462	4.03	200 feet off East 134th street ferry house	40 47 56	73 54 31	50	Flood	21.0	26	3.09	56

19—CROSS-SECTION OF HUDSON RIVER BETWEEN PIER A, MANHATTAN, AND C. R.R. OF N. J. FERRY HOUSE JERSEY CITY. JULY 19, 1911

High water occurred at Governor's Island at 1.53 P. M. Low water at 7.27 A. M.

	A .M.									
463	9.15	200 feet off Pier A	40 42 16	74 01 10	1	Ebb	23.0	42	3.09	55
464	9.16	200 feet off Pier A	40 42 16	74 01 10	20	Ebb	23.0	38	2.95	53
465	9.18	200 feet off Pier A	40 42 16	74 01 10	40	Ebb	23.0	36	2.95	53
466	9.30	¼ way across from Pier A	40 42 17	74 01 20	1	Ebb	23.0	42	3.09	55
467	9.31	¼ way across from Pier A	40 42 17	74 01 20	20	Ebb	23.0	38	3.09	55
468	9.33	¼ way across from Pier A	40 42 17	74 01 20	40	Ebb	23.0	36	3.09	55
469	9.45	Midstream	40 42 19	74 01 34	1	Ebb	23.0	46	3.24	58
470	9.46	Midstream	40 42 19	74 01 34	20	Ebb	23.0	40	3.24	58
471	9.48	Midstream	40 42 19	74 01 34	40	Ebb	23	38	3.24	58
472	10.00	¾ way across from Pier A	40 42 21	74 01 48	1	Ebb	23.0	46	3.09	55
473	10.01	¾ way across from Pier A	40 42 21	74 01 48	20	Ebb	23.0	40	3.24	58
474	10.03	¾ way across from Pier A	40 42 21	74 01 48	35	Ebb	23.0	40	3.24	58
475	10.15	200 feet off C. R.R. of N. J. ferry house	40 42 22	74 01 59	1	Ebb	23.0	48	3.09	55
476	10.16	200 feet off C. R.R. of N. J. ferry house	40 42 22	74 01 59	20	Ebb	23.0	44	3.24	58
477	10.18	200 feet off C. R.R. of N. J. ferry house	40 42 22	74 01 59	30	Ebb	23.0	44	3.24	58

20—HUDSON RIVER, CROSS-SECTION OF PIER A, MANHATTAN, TO C. R.R. OF N. J. FERRY HOUSE, JERSEY CITY. JULY 20, 1911

High water occurred at Governor's Island at 2.53 P. M. Low water at 8.27 A M.

	A. M.									
478	9.15	100 feet off Pier A	40 42 16	74 01 09	1	Ebb	23.0	40	2.95	53
479	9.16	100 feet off Pier A	40 42 16	74 01 09	20	Ebb	22.0	36	2.95	53
480	9.18	100 feet off Pier A	40 42 16	74 01 09	40	Ebb	22.0	36	2.95	53
481	9.23	¼ way across Pier from A	40 42 17	74 01 20	1	Ebb	23.0	40	3.00	54

TABLE XXVII—Continued

20—HUDSON RIVER, CROSS-SECTION OF PIER A, MANHATTAN, TO C. R.R. OF N. J. FERRY HOUSE, JERSEY CITY. JULY 20, 1911—Continued.

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
482	9.24	¼ way across from Pier A	40 42 17	74 01 20	20	Ebb	22.0	36	3.00	54
483	9.26	¼ way across from Pier A	40 42 17	74 01 20	40	Ebb	22.0	36	3.00	54
484	9.33	Midstream	40 42 19	74 01 34	1	Ebb	23.0	40	3.01	54
485	9.34	Midstream	40 42 19	74 01 34	20	Ebb	22.0	36	3.01	54
486	9.36	Midstream	40 42 19	74 01 34	40	Ebb	22.0	36	3.01	54
487	9.40	¾ way across from Pier A	40 42 21	74 01 48	1	Ebb	23.0	40	3.10	55
488	9.41	¾ way across from Pier A	40 42 21	74 01 48	20	Ebb	22.0	36	3.10	55
489	9.43	¾ way across from Pier A	40 42 21	74 01 48	35	Ebb	22.0	36	3.10	55
490	9.46	100 feet off C. R.R. of N. J. ferry house	40 42 22	74 01 59	1	Ebb	23.0	40	3.03	54
491	9.47	100 feet off C. R.R. of N. J. ferry house	40 42 22	74 01 59	20	Ebb	22.0	36	3.03	54
492	9.48	100 feet off C. R.R. of N. J. ferry house	40 42 22	74 01 59	30	Ebb	22.0	36	3.03	54
	P. M.									
493	12.15	100 feet off Pier A, N. Y.	40 42 16	74 01 09	1	Flood	23.0	40	3.09	55
494	12.16	100 feet off Pier A, N. Y.	40 42 16	74 01 09	20	Flood	22.0	36	3.09	55
495	12.18	100 feet off Pier A, N. Y.	40 42 16	74 01 09	40	Flood	22.0	36	3.09	55
496	12.23	¼ way across from Pier A	40 42 17	74 01 20	1	Flood	23.0	40	3.14	56
497	12.24	¼ way across from Pier A	40 42 17	74 01 20	20	Flood	22.0	36	3.14	56
498	12.26	¼ way across from Pier A	40 42 17	74 01 20	40	Flood	22.0	36	3.14	56
499	12.31	Midstream	40 42 19	74 01 34	1	Flood	23.0	40	3.15	56
500	12.32	Midstream	40 42 19	74 01 34	20	Flood	22.0	36	3.15	56
501	12.34	Midstream	40 42 19	74 01 34	40	Flood	22.0	36	3.15	56
502	12.39	¾ way across from Pier A	40 42 21	74 01 48	1	Flood	23.0	40	3.24	58
503	12.40	¾ way across from Pier A	40 42 21	74 01 48	20	Flood	22.0	36	3.24	58
504	12.42	¾ way across from Pier A	40 42 21	74 01 48	35	Flood	22.0	36	3.24	58
505	12.47	100 feet off C. R.R. of N. J. ferry house	40 42 22	74 01 59	1	Flood	23.0	40	3.17	57
506	12.48	100 feet off C. R.R. of N. J. ferry house	40 42 22	74 01 59	20	Flood	22.0	36	3. 7	57
507	12.50	100 feet off C. R.R. of N. J. ferry house	40 42 22	74 01 59	30	Flood	22.0	36	3.17	57
508	2.15	100 feet off Pier A, N. Y.	40 42 16	74 01 09	1	Flood	23.0	38	3.24	58
509	2.16	100 feet off Pier A, N. Y.	40 42 16	74 01 09	20	Flood	22.0	36	3.24	58
510	2.18	100 feet off Pier A, N. Y.	40 42 16	74 01 09	40	Flood	22.0	36	3.24	58
511	2.22	¼ way across from Pier A	40 42 17	74 01 20	1	Flood	23.0	38	3.29	59
512	2.23	¼ way across from Pier A	40 42 17	74 01 20	20	Flood	22.0	32	3.29	59
513	2.25	¼ way across from Pier A	40 42 17	74 01 20	40	Flood	22.0	32	3.29	59
514	2.30	Midstream	40 42 19	74 01 34	1	Flood	23.0	38	3.29	59
515	2.31	Midstream	40 42 19	74 01 34	20	Flood	22.0	30	3.29	59
516	2.33	Midstream	40 42 19	74 01 34	40	Flood	22.0	30	3.29	59
517	2.38	¾ way across from Pier A	40 42 21	74 01 48	1	Flood	23.0	38	3.24	58
518	2.39	¾ way across from Pier A	40 42 21	74 01 48	20	Flood	22.0	30	3.24	58
519	2.41	¾ way across from Pier A	40 42 21	74 01 48	35	Flood	22.0	30	3.24	58
520	2.46	100 feet off C. R. R. of N. J. ferry-house	40 42 22	74 01 59	1	Flood	23.0	38	3.17	57
521	2.47	100 feet off C. R. R. of N. J. ferry-house	40 42 22	74 01 59	20	Flood	22.0	30	3.17	57
522	2.49	100 feet off C. R. R. of N. J. ferry-house	40 42 22	74 01 59	30	Flood	22.0	30	3.17	57

21—EAST RIVER, CROSS-SECTION OF EAST RIVER FROM THROGS NECK (LANDING WEST OF LIGHT) TO WHITESTONE LANDING. JULY 21, 1911

High water occurred at Governor's Island at 4.08 P. M. Low water at 9.42 A. M.

	A. M.									
523	11.20	300 feet off Throgs Neck	40 48 27	73 48 16	1	Flood	20.0	24	4.01	72
524	11.21	300 feet off Throgs Neck	40 48 27	73 48 16	25	Flood	19.5	22	4.00	71
525	11.23	300 feet off Throgs Neck	40 48 27	73 48 16	40	Flood	19.5	22	4.00	71
526	11.43	¼ way across from Throgs Neck	40 48 20	73 48 18	1	Flood	20.0	24	4.01	72

TABLE XXVII—Continued

21—EAST RIVER, CROSS-SECTION OF EAST RIVER FROM THROGS NECK (LANDING WEST OF LIGHT) TO WHITESTONE LANDING. JULY 21, 1911—Continued

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
527	11.44	¼ way across from Throgs Neck......	40 48 20	73 48 18	20	Flood	19.5	22	4.00	71
528	11.46	¼ way across from Throgs Neck......	40 48 20	73 48 18	40	Flood	19.5	22	4.00	71
529	P. M. 12.20	Half-way across....................	40 48 09	73 48 21	1	Flood	20.0	24	4.01	72
530	12.21	Half-way across....................	40 48 09	73 48 21	20	Flood	19.5	22	4.00	71
531	12.23	Half-way across....................	40 48 09	73 48 21	35	Flood	19.5	22	4.00	71
532	12.43	¾ way across from Throgs Neck......	40 47 58	73 48 24	1	Flood	20.0	24	4.01	72
533	12.44	¾ way across from Throgs Neck......	40 47 58	73 48 24	20	Flood	19.5	22	4.00	71
534	12.46	¾ way across from Throgs Neck......	40 47 58	73 48 24	30	Flood	19.5	22	4.00	71
535	1.10	300 feet off Whitestone landing.......	40 47 50	73 48 28	1	Flood	20.0	24	4.01	72
536	1.11	300 feet off Whitestone landing.......	40 47 50	73 48 28	20	Flood	19.5	22	4.00	71
537	1.13	300 feet off Whitestone landing.......	40 47 50	73 48 28	30	Flood	19.5	22	4.00	71

22—HUDSON RIVER FROM MOUTH TO YONKERS. JULY 25, 1911

High water occurred at Governor's Island at 7.23 A. M. Low water at 1.47 P. M.
High water occurred at Hell Gate at 9.20 A. M. Low water at 3.16 P. M.

538	A. M. 9.10	Midway between Pier A and C. R. R. of N. J. ferry, Jersey City...........	40 42 19	74 01 34	1	Ebb	21.0	32	3.00	54
539	9.12	Midway between Pier A and C. R. R. of N. J. ferry, Jersey City...........	40 42 19	74 01 34	40	Ebb	21.0	28	3.00	54
540	9.30	Midstream off West 23d st...........	40 45 09	74 01 00	1	Ebb	21.5	38	3.01	54
541	9.32	Midstream off West 23d st...........	40 45 09	74 01 00	40	Ebb	21.0	32	2.80	51
542	10.35	Midstream off West 42d st...........	40 45 50	74 00 35	1	Ebb	22.0	40	2.86	51
543	10.37	Midstream off West 42d st...........	40 45 50	74 00 35	40	Ebb	21.5	36	2.86	51
544	11.00	Midstream off West 72d st...........	40 47 02	73 59 42	1	Ebb	23.0	42	3.29	59
545	11.02	Midstream off West 72d st...........	40 47 02	73 59 42	40	Ebb	22.0	40	3.15	56
546	P. M. 12.15	Midstream off West 129th st.........	40 49 16	73 58 10	1	Ebb	23.5	52	4.00	71
547	12.17	Midstream off West 129th st.........	40 49 16	73 58 10	30	Ebb	23.0	50	3.86	69
548	1.00	Midstream off Ft. Washington point..	40 51 04	73 57 13	1	Ebb	23.5	64	4.24	75
549	1.05	Midstream off Ft. Washington point..	40 51 04	73 57 13	30	Ebb	23.0	56	3.70	65
550	2.15	Midstream off Spuyten Duyvil creek...	40 52 50	73 56 04	1	Ebb	23.5	66	4.43	78
551	2.17	Midstream off Spuyten Duyvil creek...	40 52 50	73 56 04	30	Ebb	23.0	60	3.86	68
552	3.00	Midstream off Mt. St. Vincent.......	40 54 50	73 55 15	1	Ebb	24.0	72	4.94	87
553	3.02	Midstream off Mt. St. Vincent.......	40 54 50	73 55 15	30	Ebb	23.5	68	4.66	82
554	3.30	Midstream off point 1000 feet above Power house at Northern end of Yonkers........................	40 57 06	73 54 31	1	Ebb	24.0	76	5.44	96
555	3.32	Midstream off point 1000 feet above Power house at Northern end of Yonkers........................	40 57 06	73 54 31	30	Ebb	23.5	72	5.29	93

23—HUDSON RIVER FROM MOUTH TO YONKERS. JULY 26, 1911

High water at Governor's Island at 8.23 A. M. Low water at 2.47 P. M.
High water at Hell Gate at 10.15 A. M. Low water at 4.14 P. M.

556	A. M. 10.15	Midway between Pier A and C. R. R. of N. J. ferry, Jersey City.........	40 42 19	74 01 34	1	Ebb	22.0	32	3.14	57
557	10.16	Midway between Pier A and C. R. R. of N. J. ferry, Jersey City.........	40 42 19	74 01 34	20	Ebb	21.5	32	3.29	59
558	10.18	Midway between Pier A and C. R. R. of N. J. ferry, Jersey City.........	40 42 19	74 01 34	40	Ebb	21.5	32	3.29	59

TABLE XXVII—Continued

23—HUDSON RIVER FROM MOUTH TO YONKERS. JULY 26, 1911—Continued

Sample No.	Hour A. M.	Location of Samples: Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen: C. C. per litre	Oxygen: Per cent. saturation
			° ′ ″	° ′ ″						
559	10.35	Midstream off Canal st.	40 43 38	74 01 17	1	Ebb	22.0	36	2.80	51
560	10.36	Midstream off Canal st.	40 43 38	74 01 17	20	Ebb	21.5	32	3.15	57
561	10.38	Midstream off Canal st.	40 43 38	74 01 17	40	Ebb	21.5	32	3.15	57
562	10.55	Midstream off West 23d st.	40 45 09	74 01 00	1	Ebb	22.0	36	3.00	54
563	10.56	Midstream off West 23d st.	40 45 09	74 01 00	20	Ebb	21.5	32	3.29	59
564	10.58	Midstream off West 23d st.	40 45 09	74 01 00	40	Ebb	21.5	32	3.29	59
565	11.20	Midstream off West 42d st.	40 45 50	74 00 35	1	Ebb	22.0	38	3.01	54
566	11.21	Midstream off West 42d st.	40 45 50	74 00 35	20	Ebb	22.0	36	2.80	51
567	11.23	Midstream off West 42d st.	40 45 50	74 00 35	40	Ebb	22.0	34	2.80	51
568	12.00	Midstream off West 72d st.	40 47 02	73 59 42	1	Ebb	23.0	42	3.00	54
	P. M.									
569	12.01	Midstream off West 72d st.	40 47 02	73 59 42	20	Ebb	22.0	38	3.43	61
570	12.03	Midstream, off West 72d street.	40 47 02	73 59 42	40	Ebb	22.0	38	3.43	61
571	1.00	Midstream, off West 110th street.	40 48 32	73 58 40	1	Ebb	23.0	48	3.57	64
572	1.01	Midstream, off West 110th street.	40 48 32	73 58 40	20	Ebb	22.0	40	3.57	64
573	1.03	Midstream, off West 110th street.	40 48 32	73 58 40	40	Ebb	22.0	40	3.57	64
574	1.20	Midstream, off West 129th street.	40 49 16	73 58 10	1	Ebb	23.5	52	4.00	71
575	1.21	Midstream, off West 129th street.	40 49 16	73 58 10	20	Ebb	23.0	44	3.72	66
576	1.23	Midstream, off West 129th street.	40 49 16	73 58 10	30	Ebb	23.0	42	3.72	66
577	1.40	Midstream, off West 157th street.	40 50 21	73 57 29	1	Ebb	23.5	52	4.09	73
578	1.41	Midstream, off West 157th street.	40 50 21	73 57 29	20	Ebb	23.0	44	3.70	66
579	1.43	Midstream, off West 157th street.	40 50 21	73 57 29	30	Ebb	23.0	44	3.70	66
580	2.00	Midstream, off Fort Washington Point	40 51 04	73 57 13	1	Ebb	23.5	52	4.26	76
581	2.01	Midstream, off Fort Washington Point	40 51 04	73 57 13	20	Ebb	23.0	46	3.86	69
582	2.03	Midstream, off Fort Washington Point	40 51 04	73 57 13	30	Ebb	23.0	46	3.86	69
583	2.15	Midstream, off Inwood.	40 52 20	73 56 04	1	Ebb	23.5	56	4.24	76
584	2.16	Midstream, off Inwood.	40 52 20	73 56 04	20	Ebb	23.0	52	3.84	69
585	2.18	Midstream, off Inwood.	40 52 20	73 56 04	30	Ebb	23.0	52	3.84	69
586	2.30	Midstream, off Spuyten Duyvil creek.	40 52 50	73 56 04	1	Ebb	23.5	58	4.26	76
587	2.31	Midstream, off Spuyten Duyvil creek.	40 52 50	73 56 04	20	Ebb	23.0	54	3.86	69
588	2.33	Midstream, off Spuyten Duyvil creek.	40 52 50	73 56 04	30	Ebb	23.0	54	3.86	69
589	2.45	Midstream, off Riverdale.	40 54 10	73 55 25	1	Ebb	24.0	62	4.94	88
590	2.46	Midstream, off Riverdale.	40 54 10	73 55 25	20	Ebb	23.5	58	4.38	78
591	2.48	Midstream, off Riverdale.	40 54 10	73 55 25	30	Ebb	23.5	58	4.38	78
592	3.00	Midstream, off Mt. St. Vincent.	40 54 50	73 55 15	1	Ebb	24.0	64	5.05	90
593	3.01	Midstream, off Mt. St. Vincent.	40 54 50	73 55 15	20	Ebb	23.5	60	4.58	82
594	3.03	Midstream, off Mt. St. Vincent.	40 54 50	73 55 15	30	Ebb	23.5	60	4.58	82
595	3.15	Midstream, off Power House, Yonkers	40 56 55	73 54 35	1	Ebb	24.0	70	5.44	96
596	3.16	Midstream, off Power House, Yonkers	40 56 55	73 54 35	20	Ebb	23.5	66	5.21	91
597	3.18	Midstream, off Power House, Yonkers	40 56 55	73 54 35	30	Ebb	23.5	66	5.07	90

24—EAST RIVER, CROSS-SECTION FROM PIER 10, MANHATTAN, TO PIER 10, BROOKLYN. JULY 27, 1911

High water at Governor's Island at 9.23 A. M. Low water at 3.36 P. M.

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
	A. M.									
598	9.30	100 feet off Pier 10, Manhattan.	40 42 09	74 00 22	1	Flood	22.0	34	2.97	54
599	9.31	100 feet off Pier 10, Manhattan.	40 42 09	74 00 22	20	Flood	22.0	30	2.97	54
600	9.33	100 feet off Pier 10, Manhattan.	40 42 09	74 00 22	35	Flood	22.0	30	2.97	54
601	9.38	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	1	Flood	22.0	34	3.03	55
602	9.39	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	20	Flood	22.0	30	3.03	55
603	9.41	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	40	Flood	22.0	30	3.03	55
604	9.46	Midstream.	40 42 03	74 00 11	1	Flood	22.0	32	3.24	59
605	9.47	Midstream.	40 42 03	74 00 11	20	Flood	22.0	30	3.38	60

TABLE XXVII—Continued

24—EAST RIVER, CROSS-SECTION FROM PIER 10, MANHATTAN, TO PIER 10, BROOKLYN, JULY 27, 1911—Continued

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
606	9.49	Midstream	40 42 03	74 00 11	40	Flood	22.0	30	3.38	60
607	9.54	¾ way across from Pier 10, Manhattan	40 42 00	74 00 05	1	Flood	22.0	30	3.14	57
608	9.55	¾ way across from Pier 10, Manhattan	40 42 00	74 00 05	20	Flood	22.0	28	3.29	59
609	9.57	¾ way across from Pier 10, Manhattan	40 42 00	74 00 05	35	Flood	22.0	28	3.29	59
610	10.02	100 feet off Pier 10, Brooklyn	40 41 57	74 00 00	1	Flood	22.0	30	3.01	55
611	10.03	100 feet off Pier 10, Brooklyn	40 41 57	74 00 00	20	Flood	22.0	28	3.01	55
612	10.05	100 feet off Pier 10, Brooklyn	40 41 57	74 00 00	35	Flood	22.0	28	3.01	55
613	12.00	100 feet off Pier 10, Manhattan	40 42 09	74 00 22	1	Ebb	22.0	28	2.81	51
	P. M.									
614	12.01	100 feet off Pier 10, Manhattan	40 42 09	74 00 22	20	Ebb	22.0	28	2.81	51
615	12.03	100 feet off Pier 10, Manhattan	40 42 09	74 00 22	35	Ebb	22.0	28	2.81	51
616	12.08	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	1	Ebb	22.0	28	2.90	53
617	12.09	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	20	Ebb	22.0	28	2.90	53
618	12.11	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	40	Ebb	22.0	28	2.90	53
619	12.16	Midstream	40 42 03	74 00 11	1	Ebb	22.0	28	3.09	56
620	12.17	Midstream	40 42 03	74 00 11	20	Ebb	22.0	28	3.24	59
621	12.19	Midstream	40 42 03	74 00 11	40	Ebb	22.0	28	3.24	59
622	12.24	¾ way across from Pier 10, Manhattan	40 42 00	71 00 05	1	Ebb	22.0	28	3.00	55
623	12.25	¾ way across from Pier 10, Manhattan	40 42 00	71 00 05	20	Ebb	22.0	28	3.14	57
624	12.27	¾ way across from Pier 10, Manhattan	40 42 00	71 00 05	35	Ebb	22.0	28	3.14	57
625	12.32	100 feet off Pier 10, Brooklyn	40 41 57	74 00 00	1	Ebb	22.0	28	2.88	52
626	12.33	100 feet off Pier 10, Brooklyn	40 41 57	74 00 00	20	Ebb	22.0	28	2.88	52
627	12.35	100 feet off Pier 10, Brooklyn	40 41 57	74 00 00	35	Ebb	22.0	28	2.88	52
628	2.00	100 feet off Pier 10, Manhattan	40 42 09	74 00 22	1	Ebb	22.0	30	2.70	49
629	2.01	100 feet off Pier 10, Manhattan	40 42 09	74 00 22	20	Ebb	22.0	30	2.70	49
630	2.03	100 feet off Pier 10, Manhattan	40 42 09	74 00 22	35	Ebb	22.0	30	2.70	49
631	2.08	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	1	Ebb	22.0	30	2.76	51
632	2.09	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	20	Ebb	22.0	30	2.76	51
633	2.11	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	40	Ebb	22.0	30	2.76	51
634	2.16	Midstream	40 42 03	74 00 11	1	Ebb	22.0	30	2.95	54
635	2.17	Midstream	40 42 03	74 00 11	20	Ebb	22.0	30	3.09	56
636	2.19	Midstream	40 42 03	74 00 11	40	Ebb	22.0	30	3.09	56
637	2.24	¾ way across from Pier 10, Manhattan	40 42 00	71 00 05	1	Ebb	22.0	30	2.86	52
638	2.25	¾ way across from Pier 10, Manhattan	40 42 00	71 00 05	20	Ebb	22.0	30	2.86	52
639	2.27	¾ way across from Pier 10, Manhattan	40 42 00	71 00 05	35	Ebb	22.0	30	2.86	52
640	2.32	100 feet off Pier 10, Brooklyn	40 41 57	74 00 00	1	Ebb	22.0	30	2.74	50
641	2.33	100 feet off Pier 10, Brooklyn	40 41 57	74 00 00	20	Ebb	22.0	30	2.74	50
642	2.35	100 feet off Pier 10, Brooklyn	40 41 57	74 00 00	35	Ebb	22.0	30	2.74	50

25—EAST RIVER, CROSS-SECTION FROM THROGS NECK TO WHITESTONE LANDING. JULY 28, 1911

High water at Governor's Island at 10.23 A. M. Low water at 4.52 P. M.
High water at Hell Gate at 12.10 P. M. Low water at 6.00 P. M.

	A. M.									
643	12.00	300 feet off west landing, Throgs Neck	40 48 27	73 48 16	1	Ebb	19.0	22	4.71	84
	P. M.									
644	12.01	300 feet off west landing, Throgs Neck	40 48 27	73 48 16	25	Ebb	19.0	22	4.71	84
645	12.03	300 feet off west landing, Throgs Neck	40 48 27	73 48 16	40	Ebb	19.0	22	4.71	84
646	12.20	¼ way across from Throgs Neck	40 48 20	73 48 18	1	Ebb	19.0	22	4.71	84
647	12.21	¼ way across from Throgs Neck	40 48 20	73 48 18	20	Ebb	19.0	22	4.71	84
648	12.23	¼ way across from Throgs Neck	40 48 20	73 48 18	40	Ebb	19.0	22	4.71	84
649	12.40	Midstream	40 48 09	73 48 21	1	Ebb	19.0	22	4.71	84
650	12.41	Midstream	40 48 09	73 48 21	20	Ebb	19.0	22	4.71	84

TABLE XXVII—Continued

25—EAST RIVER, CROSS-SECTION FROM THROGS NECK TO WHITESTONE LANDING. JULY 28, 1911—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
651	12.43	Midstream	40 48 09	73 48 21	35	Ebb	19.0	22	4.71	84
652	1.00	¾ way across from Throgs neck	40 47 58	73 48 24	1	Ebb	19.0	22	4.71	84
653	1.01	¾ way across from Throgs Neck	40 47 58	73 48 24	20	Ebb	19.0	22	4.71	84
654	1.03	¾ way across from Throgs Neck	40 47 58	73 48 24	30	Ebb	19.0	22	4.71	84
655	1.20	300 feet off Whitestone landing	40 47 50	73 48 28	1	Ebb	19.0	22	4.71	84
656	1.21	300 feet off Whitestone landing	40 47 50	73 48 28	20	Ebb	19.0	22	4.71	84
657	1.23	300 feet off Whitestone landing	40 47 50	73 48 28	30	Ebb	19.0	22	4.71	84

26—BUTTERMILK CHANNEL. JULY 31, 1911

High water at Governor's Island at 12.23 P. M. Low water at 6.47 P. M.

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
	A. M.									
658	11.15	200 feet off Degraw street slip, Brooklyn	40 41 15	74 00 32	1	Flood	22.0	26	2.95	54
659	11.16	200 feet off Degraw street slip, Brooklyn	40 41 15	74 00 32	20	Flood	22.0	26	2.95	54
660	11.18	200 feet off Degraw street slip, Brooklyn	40 41 15	74 00 32	35	Flood	22.0	26	2.95	54
661	11.25	50 feet off Degraw street slip	40 41 14	74 00 31	1	Flood	22.0	26	2.86	52
662	11.26	50 feet off Degraw street slip	40 41 14	74 00 31	20	Flood	22.0	26	2.86	52
663	11.28	50 feet off Degraw street slip	40 41 14	74 00 31	30	Flood	22.0	26	2.86	52
664	11.35	Degraw street slip, outer end	40 41 14	74 00 29	1	Flood	22.0	26	1.47	27
665	11.36	Degraw street slip, outer end	40 41 14	74 00 29	20	Flood	22.0	26	2.65	48
666	11.45	Degraw street slip, inner end	40 41 13	74 00 25	1	Flood	22.0	26	1.43	26
667	11.46	Degraw street slip, inner end	40 41 13	74 00 25	10	Flood	22.0	26	1.43	26
668	12.00	200 feet off Pier 29, Brooklyn	40 41 22	74 00 26	1	Flood	22.0	26	2.95	54
	P. M.									
669	12.01	200 feet off Pier 29, Brooklyn	40 41 22	74 00 26	20	Flood	22.0	26	2.95	54
670	12.03	200 feet off Pier 29, Brooklyn	40 41 22	74 00 26	30	Flood	22.0	26	2.95	54
671	12.20	200 feet off east end of Pier 33, Brooklyn	40 41 11	74 00 35	1	Flood	22.0	26	3.00	55
672	12.21	200 feet off east end of Pier 33, Brooklyn	40 41 11	74 00 35	20	Flood	22.0	26	3.00	55
673	12.23	200 feet off east end of Pier 33, Brooklyn	40 41 11	74 00 35	35	Flood	22.0	26	3.00	55
674	2.00	200 feet off Degraw street slip	40 41 15	74 00 32	1	Ebb	22.0	30	2.80	51
675	2.01	200 feet off Degraw street slip	40 41 15	74 00 32	20	Ebb	22.0	28	2.80	51
676	2.03	200 feet off Degraw street slip	40 41 15	74 00 32	35	Ebb	22.0	28	2.80	51
677	2.10	50 feet off Degraw street slip	40 41 14	74 00 30	1	Ebb	22.0	30	1.43	26
678	2.11	50 feet off Degraw street slip	40 41 14	74 00 30	20	Ebb	22.0	28	2.72	49
679	2.13	50 feet off Degraw street slip	40 41 14	74 00 30	30	Ebb	22.0	28	2.72	49
680	2.20	Degraw street slip, outer end	40 41 14	74 00 29	1	Ebb	22.0	30	0.59	11
681	2.21	Degraw street slip, outer end	40 41 14	74 00 29	20	Ebb	22.0	30	0.90	16
682	2.30	Degraw street slip, inner end	40 41 13	74 00 25	1	Ebb	22.0	30	0.286	5
683	2.31	Degraw street slip, inner end	40 41 13	74 00 25	10	Ebb	22.0	30	0.286	5
684	2.40	200 feet off Pier 29	40 41 22	74 00 26	1	Ebb	22.0	30	2.80	51
685	2.41	200 feet off Pier 29	40 41 22	74 00 26	20	Ebb	22.0	28	2.80	51
686	2.43	200 feet off Pier 29	40 41 22	74 00 26	30	Ebb	22.0	28	2.80	51
687	3.00	200 feet off east end of Pier 33	40 41 11	74 00 35	1	Ebb	22.0	30	2.28	41
688	3.00	200 feet off east end of Pier 33	40 41 11	74 00 35	20	Ebb	22.0	28	2.72	49
689	3.03	200 feet off east end of Pier 33	40 41 11	74 00 35	35	Ebb	22.0	28	2.72	49

TABLE XXVII—Continued

27—GOWANUS CANAL. JULY 31, 1911

High water at Governor's Island at 12.23 P. M. Low water at 6.47 P. M.

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
690	3.30	At mouth of Gowanus canal, 25th street	40 39 55	74 00 25	1	Flood	23 0	30	1.77	32
691	3.31	At mouth of Gowanus canal, 25th street	40 39 55	74 00 25	15	Flood	23.0	30	1.77	32
692	3.45	Hamilton Avenue Bridge............	40 40 17	73 59 56	1	Flood	23.0	30	1.43	26
693	3.46	Hamilton Avenue Bridge............	40 40 17	73 59 56	15	Flood	23.0	30	1.43	26

28—EAST RIVER AND LONG ISLAND SOUND. AUGUST 1, 1911

High water at Governor's Island at 1.33 P. M. Low water at 6.57 A. M.
High water at Hell Gate at 3.22 P. M. Low water at 8.58 A. M.

	A .M.									
694	9.20	East river, midway between Clason Point and College Point...........	40 48 00	73 51 10	1	Flood	23.0	24	3.95	73
695	9.21	East river, midway between Clason Point and College Point...........	40 48 00	73 51 10	20	Flood	22.0	24	3.95	73
696	9.23	East river, midway between Clason Point and College Point...........	40 48 00	73 51 10	40	Flood	21.5	24	3.95	73
697	9.35	East river, midway between Throgs Neck and Willet's Point...........	40 47 57	73 47 21	1	Flood	22.0	24	4.42	82
698	9.36	East river, midway between Throgs Neck and Willet's Point...........	40 47 57	73 47 21	30	Flood	21.5	22	4.42	82
699	9.38	East river, midway between Throgs Neck and Willet's Point...........	40 47 57	73 47 21	60	Flood	21.5	22	4.42	82
700	9.55	Long Island Sound, just north of Stepping Stones light..................	40 49 35	73 46 35	1	Flood	22.0	22	4.71	87
701	9.56	Long Island Sound, just north of Stepping Stones light..................	40 49 35	73 46 35	20	Flood	21.5	20	4.71	87
702	9.58	Long Island Sound, just north of Stepping Stones light..................	40 49 35	73 46 35	40	Flood	21.5	20	4.71	87
703	10.25	Long Island Sound, just south of Execution Rocks light................	40 52 30	73 44 15	1	Flood	22.0	20	5.01	96
704	10.26	Long Island Sound, just south of Execution light......................	40 52 30	73 44 15	20	Flood	21.5	20	5.01	96
705	10.28	Long Island Sound, just south of Execution Rocks light................	40 52 30	73 44 15	35	Flood	21.5	20	5.01	96

29—MANHASSET BAY, LONG ISLAND. AUGUST 1, 1911

Low water at Port Washington at 11.30 A. M.

	A. M.									
706	10.45	Midway between Barker Point and Hewlett Point, entrance of Manhasset bay......................	40 50 35	73 44 45	1	Ebb	22.0	24	5.01	93
707	10.46	Midway between Barker Point and Hewlett Point, entrance of Manhasset bay......................	40 50 35	73 44 45	15	Ebb	22.0	24	5.01	93
708	11.00	Manhasset bay, by buoy 1, off Plum Point...........................	40 49 45	73 43 30	1	Ebb	22.0	24	5.15	96
709	11.01	Manhasset bay, by buoy 1, off Plum Point...........................	40 49 45	73 43 30	10	Ebb	22.0	24	5.15	96
710	11.14	Manhasset bay, by buoy 3, off Tom Point...........................	40 49 45	73 42 40	1	Ebb	22.0	24	5.15	96
711	11.15	Manhasset bay, by buoy 3, off Tom Point...........................	40 49 45	73 42 40	10	Ebb	22.0	24	5.15	96

TABLE XXVII—Continued

29—MANHASSET BAY, LONG ISLAND. AUGUST 1, 1911—Continued

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
712	11.29	Manhasset bay, at Port Washington public dock	40 49 55	73 42 20	1	Ebb	22.0	24	5.01	93
713	11.30	Manhasset bay, at Port Washington public dock	40 49 55	73 42 20	7	Ebb	22.0	24	5.01	93
714	P. M. 1.30	Manhasset bay, at Port Washington public dock	40 49 55	73 42 20	1	Flood	22.0	22	5.30	98
715	1.31	Manhasset bay, at Port Washington public dock	40 49 55	73 42 20	9	Flood	22.0	22	5.30	98
716	2.00	Manhasset bay, by buoy 3, off Tom Point	40 49 45	73 42 40	1	Flood	22.0	20	5.44	100
717	2.01	Manhasset bay, by buoy 3, off Tom Point	40 49 45	73 42 40	10	Flood	22.0	20	5.44	100
718	2.30	Manhasset bay, by buoy 1, off Plum Point	40 49 45	73 43 30	1	Flood	22.0	20	5.44	100
719	2.31	Manhasset bay, by buoy 1, off Plum Point	40 49 45	73 43 30	10	Flood	22.0	20	5.44	100
720	2.50	Midway between Barker Point and Hewlett Point, entrance of bay	40 50 35	73 44 45	1	Flood	22.0	20	5.44	100
721	2.51	Midway between Barker Point and Hewlett Point, entrance of bay	40 50 35	73 44 45	15	Flood	22.0	20	5.44	100

30—LONG ISLAND SOUND AND EAST RIVER. AUGUST 1, 1911

722	P. M. 3.20	Long Island Sound, just south of Execution Rocks light	40 52 30	73 44 15	1	Ebb	21.5	18	5.44	100
723	3.21	Long Island Sound, just south of Execution Rocks light	40 52 30	73 44 15	20	Ebb	21.5	18	5.44	100
724	3.23	Long Island Sound, just south of Execution Rocks light	40 52 30	73 44 15	35	Ebb	21.5	18	5.44	100
725	4.00	Long Island Sound, just north of Stepping Stones light	40 49 35	73 46 35	1	Ebb	21.5	18	5.05	94
726	4.01	Long Island Sound, just north of Stepping Stones light	40 49 35	73 46 35	20	Ebb	21.5	18	5.05	94
727	4.03	Long Island Sound, just north of Stepping Stones light	40 49 35	73 46 35	40	Ebb	21.5	18	5.05	94
728	4.30	East river, midway between Throgs Neck and Willet's Point	40 47 57	73 47 21	1	Ebb	22.0	18	4.86	90
729	4.31	East river, midway between Throgs Neck and Willet's Point	40 47 57	73 47 21	30	Ebb	21.5	18	4.86	90
730	4.33	East river, midway between Throgs Neck and Willet's Point	40 47 57	73 47 21	60	Ebb	21.5	18	4.86	90
731	5.15	East river, midway between Clason Point and College Point	40 48 00	73 51 10	1	Ebb	22.0	20	4.58	85
732	5.16	East river, midway between Clason Point and College Point	40 48 00	73 51 10	20	Ebb	21.5	18	4.58	85
733	5.18	East river, midway between Clason Point and College Point	40 48 00	73 51 10	40	Ebb	21.5	18	4.58	85

TABLE XXVII—Continued

31—LOWER NEW YORK BAY. AUGUST 2, 1911

High water at Governor's Island at 1.32 P. M. Low water at 7.18 A. M.
High water at Sandy Hook at 12.54 P. M. Low water at 6.32 A. M.

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
734	10.05	Midway between South Beach, S. I., and Hoffman Island	40 35 00	74 03 35	1	Flood	21.5	20	5.44	100
735	10.06	Midway between South Beach, S. I., and Hoffman Island	40 35 00	74 03 35	15	Flood	21.5	20	5.44	100
736	10.25	Midway between Midland Beach and Swinburne Island	40 34 20	74 03 50	1	Flood	21.5	20	5.44	100
737	10.26	Midway between Midland Beach and Swinburne Island	40 34 20	74 03 50	15	Flood	21.5	18	5.44	100
738	10.45	1 mile off Elm Tree beacon on line with West Bank light	40 33 20	74 04 45	1	Flood	21.5	18	5.44	100
739	10.46	1 mile off Elm Tree beacon on line with West Bank light	40 33 20	74 04 45	15	Flood	21.5	18	5.44	100
	P. M.									
740	12.05	By nun buoy 2, west of Old Orchard light	40 30 55	74 07 00	1	Flood	21.5	18	5.44	100
741	12.06	By nun buoy 2, west of Old Orchard light	40 30 55	74 07 00	15	Flood	21.5	18	5.44	100

32—RARITAN BAY. AUGUST 2, 1911

742	12.20	By spar buoy 4, off Seguine Point	40 30 35	74 09 10	1	Flood	21.5	18	5.44	100
743	12.21	By spar buoy 4, off Seguine Point	40 30 35	74 09 10	15	Flood	21.5	18	5.44	100
744	12.35	By spar buoy 4½, off Seguine Point	40 30 15	74 10 05	1	Flood	21.5	18	5.44	100
745	12.36	By spar buoy 4½, off Seguine Point	40 30 15	74 10 05	15	Flood	21.5	18	5.44	100
746	12.50	By spar buoy 3, off Seguine Point	40 30 30	74 11 20	1	Flood	21.5	20	5.44	100
747	12.51	By spar buoy 3, off Seguine Point	40 30 30	74 11 20	15	Flood	21.5	20	5.44	100
748	1.05	By can buoy 5, off Princess bay	40 30 30	74 12 20	1	Flood	22.0	22	5.44	100
749	1.06	By can buoy 5, off Princess bay	40 30 20	74 12 20	15	Flood	22.0	22	5.44	100
750	1.20	By nun buoy 6, farther west	40 29 45	74 13 35	1	Flood	22.0	22	5.44	100
751	1.21	By nun buoy 6, farther west	40 29 45	74 13 35	15	Flood	22.0	22	5.44	100
752	1.35	By buoy 8, off Great Beds light	40 29 05	74 14 20	1	Flood	22.0	22	5.44	100
753	1.36	By buoy 8, off Great Beds light	40 29 05	74 14 20	15	Flood	22.0	22	5.44	100

33—CHEESEQUAKE CREEK, NEW JERSEY. AUGUST 2, 1911

754	1.50	1 mile off Cheesequake creek in Raritan bay	40 28 35	74 15 05	1	Flood	22.0	22	5.44	100
755	1.51	1 mile off Cheesequake creek in Raritan bay	4 28 35	74 15 05	7	Flood	22.0	22	5.44	100
756	2.02	Cheesequake creek at mouth	40 27 50	74 15 30	1	Flood	22.0	22	5.45	100
757	2.03	Cheesequake creek at mouth	40 27 50	74 15 30	6	Flood	22.0	22	5.45	100
758	2.02	Cheesequake creek at mouth	40 27 50	74 15 30	1	Flood	22.0	22	5.44	100
759	2.03	Cheesequake creek at mouth	40 27 50	74 15 30	6	Flood	22.0	22	5.44	100
760	2.25	Cheesequake creek just below drawbridge	40 27 45	74 15 40	1	Flood	22.0	26	5.45	100
761	2.26	Cheesequake creek just below drawbridge	40 27 45	74 15 40	6	Flood	22.0	26	5.45	100
762	2.25	Cheesequake creek just below drawbridge	40 27 45	74 15 40	1	Flood	22.0	26	5.44	100
763	2.26	Cheesequake creek just below drawbridge	40 27 45	74 15 40	6	Flood	22.0	26	5.44	100

TABLE XXVII—Continued

34—RARITAN BAY. AUGUST 2, 1911

Sample No.	Hour P. M.	Location of Samples: Approximate	Location of Samples: Latitude ° ′ ″	Location of Samples: Longitude ° ′ ″	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen: C. C. per litre	Oxygen: Per cent. saturation
764	2.48	Raritan bay just north of Great Beds light	40 29 15	74 15 10	1	Flood	22.0	22	5.45	100
765	2.49	Raritan bay just north of Great Beds light	40 29 15	74 15 10	15	Flood	22.0	22	5.45	100
766	3.00	By red and black buoy at entrance of Arthur Kill	40 30 15	74 15 35	1	Flood	22.0	22	5.44	100
767	3.01	By red and black buoy at entrance of Arthur Kill	40 30 15	74 15 35	15	Flood	22.0	22	5.44	100

35—EAST RIVER CROSS-SECTION BETWEEN PIER 10, MANHATTAN, AND PIER 10, BROOKLYN. AUGUST 3, 1911

High water at Governor's Island at 3.13 P. M. Low water at 9. 07 A. M.

768	A. M. 9.10	100 feet off Pier 10, Manhattan	40 42 09	74 00 22	1	Ebb	22.0	28	2.70	49
769	9.11	100 feet off Pier 10, Manhattan	40 42 09	74 00 22	20	Ebb	22.0	26	2.97	54
770	9.13	100 feet off Pier 10, Manhattan	40 42 09	74 00 22	30	Ebb	22.0	26	2.97	54
771	9.18	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	1	Ebb	22.0	28	2.76	51
772	9.19	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	20	Ebb	22.0	26	3.03	55
773	9.21	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	40	Ebb	22.0	26	3.03	55
774	9.26	Midstream	40 42 03	74 00 11	1	Ebb	22.0	28	2.95	54
775	9.27	Midstream	40 42 03	74 00 11	20	Ebb	22.0	26	3.09	56
776	9.29	Midstream	40 42 03	74 00 11	40	Ebb	22.0	26	3.09	56
777	9.34	¾ way across from Pier 10, Manhattan	40 42 00	71 00 05	1	Ebb	22.0	28	2.86	52
778	9.35	¾ way across from Pier 10, Manhattan	40 42 00	71 00 05	20	Ebb	22.0	28	3.00	55
779	9.37	¾ way across from Pier 10, Manhattan	40 42 00	71 00 05	35	Ebb	22.0	26	3.00	55
780	9.42	100 feet off Pier 10, Brooklyn	40 41 57	74 00 00	1	Ebb	22.0	28	2.74	50
781	9.43	100 feet off Pier 10, Brooklyn	40 41 57	74 00 00	20	Ebb	22.0	26	2.88	52
782	9.45	100 feet off Pier 10, Brooklyn	40 41 57	74 00 00	35	Ebb	22.0	26	2.88	52
783	11.55	100 feet off Pier 10, Manhattan	40 42 09	74 00 22	1	Flood	23.0	32	2.97	54
784	11.56	100 feet off Pier 10, Manhattan	40 42 09	74 00 22	20	Flood	22.0	30	2.97	54
785	11.58	100 feet off Pier 10, Manhattan	40 42 09	74 00 22	30	Flood	22.0	30	2.97	54
786	P. M. 12.03	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	1	Flood	23.0	32	3.03	55
787	12.04	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	20	Flood	22.0	30	3.03	55
788	12.06	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	40	Flood	22.0	30	3.03	55
789	12.11	Midstream	40 42 03	74 00 11	1	Flood	23.0	32	3.09	56
790	12.12	Midstream	40 42 03	74 00 11	20	Flood	22.0	30	3.09	56
791	12.14	Midstream	40 42 03	74 00 11	40	Flood	22.0	30	3.09	56
792	12.19	¾ way across from Pier 10, Manhattan	40 42 00	71 00 05	1	Flood	23.0	32	3.00	55
793	12.20	¾ way across from Pier 10, Manhattan	40 42 00	71 00 05	20	Flood	22.0	30	3.00	55
794	12.22	¾ way across from Pier 10, Manhattan	40 42 00	71 00 05	35	Flood	22.0	30	3.00	55
795	12.27	100 feet off Pier 10, Brooklyn	40 41 57	74 00 00	1	Flood	23.0	32	2.74	50
796	12.28	100 feet off Pier 10, Brooklyn	40 41 57	74 00 00	20	Flood	22.0	30	2.88	52
797	12.30	100 feet off Pier 10, Brooklyn	40 41 57	74 00 00	35	Flood	22.0	30	2.88	52
798	2.40	100 feet off Pier 10, Manhattan	40 42 09	74 00 22	1	Flood	23.0	34	3.24	59
799	2.41	100 feet off Pier 10, Manhattan	40 42 09	74 00 22	20	Flood	22.0	30	3.24	59
800	2.43	100 feet off Pier 10, Manhattan	40 42 09	74 00 22	30	Flood	22.0	30	3.24	59
801	2.48	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	1	Flood	23.0	34	3.31	60
802	2.49	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	20	Flood	22.0	30	3.31	60
803	2.51	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	40	Flood	22.0	30	3.31	60

TABLE XXVII—Continued

35—EAST RIVER CROSS-SECTION BETWEEN PIER 10, MANHATTAN, AND PIER 10, BROOKLYN. AUGUST 3, 1911—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
804	2.56	Midstream	40 42 03	74 00 11	1	Flood	23.0	32	3.38	61
805	2.57	Midstream	40 42 03	74 00 11	20	Flood	22.0	30	3.38	61
806	2.59	Midstream	40 42 03	74 00 11	40	Flood	22.0	30	3.38	61
807	3.04	¾ way across from Pier 10, Manhattan	40 42 00	71 00 05	1	Flood	22.0	28	3.29	60
808	3.05	¾ way across from Pier 10, Manhattan	40 42 00	71 00 05	20	Flood	22.0	28	3.29	60
809	3.07	¾ way across from Pier 10, Manhattan	40 42 00	71 00 05	35	Flood	22.0	28	3.29	60
810	3.12	100 feet off Pier 10, Brooklyn	40 41 57	74 00 00	1	Flood	22.0	28	3.29	60
811	3.13	100 feet off Pier 10, Brooklyn	40 41 57	74 00 00	20	Flood	22.0	28	3.29	60
812	3.15	100 feet off Pier 10, Brooklyn	40 41 57	74 00 00	35	Flood	22.0	28	3.29	60

36—EAST RIVER IN SLIPS AND OUTSIDE. AUGUST 4, 1911

High water occurred at Governor's Island at 4.23 P. M. Low water at 9.58 A. M.
High water occurred at Hell Gate at 5.58 P. M. Low water at 11.38 A. M.

	A. M.									
813	10.00	50 feet off end of dock at foot of East 14th street	40 43 36	73 58 19	1	Ebb	23.0	46	0.54	10
814	10.02	50 feet off end of dock at foot of East 14th street	40 43 36	73 58 19	20	Ebb	22.0	30	1.89	34
815	10.15	200 feet off end of 14th street dock	40 43 35	73 58 18	1	Ebb	22.0	28	2.56	47
816	10.17	200 feet off end of 14th street dock	40 43 35	73 58 18	25	Ebb	22.0	28	2.70	49
817	10.25	Slip north of East 24th street pier. Midway up slip	40 44 09	73 58 27	1	Ebb	23.0	28	1.32	24
818	10.26	Slip north of East 24th street pier. Midway up slip	40 44 09	73 58 27	10	Ebb	22.0	28	1.89	34
819	10.40	Inner end of slip	40 44 11	73 58 30	1	Ebb	23.0	28	1.10	20
820	10.41	Inner end of slip	40 44 11	73 58 30	10	Ebb	23.0	28	1.65	30
821	10.50	200 feet off outer end of East 24th street slip	40 44 07	73 58 20	1	Ebb	22.0	28	2.86	52
822	10.51	200 feet off outer end of East 24th street slip	40 44 07	73 58 20	25	Ebb	22.0	28	2.86	52
823	11.08	Slip between East 45th and East 46th street 20 feet from inside of slip	40 45 01	73 58 01	1	Ebb	23.0	36	1.18	21
824	11.09	Slip between East 45th and East 46th street 20 feet from inside of slip	40 45 01	73 58 01	10	Ebb	22.0	30	1.77	32
825	11.28	200 feet off outer end of 45th street slip	40 45 00	73 57 58	1	Ebb	22.0	28	2.70	49
826	11.29	200 feet off outer end of 45th street slip	40 45 00	73 57 58	25	Ebb	22.0	28	2.81	51
827	11.50	200 feet off foot of East 50th street	40 45 10	73 57 50	1	Ebb	22.0	28	2.86	52
828	11.51	200 feet off foot of East 50th street	40 45 10	73 57 50	25	Ebb	22.0	28	2.86	52

37—HARLEM RIVER. AUGUST 4, 1911

Low water in Harlem River at 12.15 P. M.

	P. M.									
829	12.10	Half way up slip between 108th and 109th street	40 47 24	73 56 11	1	Ebb	23.0	44	0.44	8
830	12.11	Half way up slip between 108th and 109th streets	40 47 24	73 56 11	10	Ebb	22.0	30	0.88	16
831	12.30	Slip between 108th and 109th streets	40 47 24	73 56 11	1	Flood	23.0	42	0.59	11
832	12.31	Slip between 108th and 109th streets	40 47 24	73 56 11	10	Flood	22.0	30	1.18	21
833	1.00	30 feet off end of East 109th street pier	40 47 25	73 56 12	1	Flood	23.0	44	1.00	18
834	1.01	30 feet off end of East 109th street pier	40 47 25	73 56 12	15	Flood	22.0	30	1.43	26
835	1.06	Midstream	40 47 23	73 56 07	1	Flood	23.0	44	1.03	19

TABLE XXVII—Continued

37—HARLEM RIVER. AUGUST 4, 1911—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
836	1.07	Midstream	40 47 23	73 56 07	20	Flood	22.0	30	1.47	27
837	1.11	30 feet off end of Ward's Island dock	40 47 20	73 56 02	1	Flood	23.0	42	1.10	20
838	1.12	30 feet off end of Ward's Island dock	40 47 20	73 56 02	15	Flood	22.0	30	1.50	27
839	2.00	Midstream off East 109th street	40 47 23	73 56 07	1	Flood	22.0	32	1.24	23
840	2.01	Midstream off East 109th street	40 47 23	73 56 07	20	Flood	22.0	32	1.24	23

38—KILL VAN KULL. AUGUST 8, 1911

High water occurred at Governor's Island at 7.03 A. M. Low water at 1.17 P. M.

	A. M.									
841	10.50	Upper bay, by Robbin's Reef bell buoy	40 39 15	74 03 50	1	Ebb	23.0	28	3.53	64
842	10.51	Upper bay, by Robbin's Reef bell buoy	40 39 15	74 03 50	20	Ebb	23.0	28	3.83	70
843	10.53	Upper bay, by Robbin's Reef bell buoy	40 39 15	74 03 50	40	Ebb	23.0	28	3.83	70
844	11.05	Kill van Kull, off Jersey street, New Brighton, midstream	40 38 57	74 05 25	1	Ebb	23.0	32	3.72	68
845	11.06	Kill van Kull, off Jersey street, New Brighton, midstream	40 38 57	74 05 25	20	Ebb	23.0	30	3.72	68
846	11.08	Kill van Kull, off Jersey street, New Brighton, midstream	40 38 57	74 05 25	40	Ebb	23.0	30	3.72	68
847	11.20	Off Sailors' Snug Harbor, midstream	40 38 50	74 06 07	1	Ebb	23.0	34	3.57	65
848	11.21	Off Sailors' Snug Harbor, midstream	40 38 50	74 06 07	20	Ebb	23.0	32	3.57	65
849	11.23	Off Sailors' Snug Harbor, midstream	40 38 50	74 06 07	35	Ebb	23.0	32	3.57	65
850	11.35	Off Port Richmond ferry, midstream	40 38 35	74 07 52	1	Ebb	23.0	34	3.83	70
851	11.36	Off Port Richmond ferry, midstream	40 38 35	74 07 52	20	Ebb	23.0	32	3.83	70
852	11.38	Off Port Richmond ferry, midstream	40 38 35	74 07 52	40	Ebb	23.0	32	3.83	70
853	11.45	By buoy S2, near west end of Kill	40 38 35	74 08 24	1	Ebb	23.0	34	4.00	73
854	11.46	By buoy S2, near west end of Kill	40 38 35	74 08 24	20	Ebb	23.0	32	4.00	73
855	11.48	By buoy S2, near west end of Kill	40 38 35	74 08 24	40	Ebb	23.0	32	4.00	73

39—NEWARK BAY. AUGUST 8, 1911

Low water at Governor's Island at 1.17 P. M. Low water at Newark at 2.00 P. M.

	P. M.									
856	12.00	200 feet west of Bergen Point light	40 38 35	74 08 58	1	Ebb	23.0	34	4.09	74
857	12.02	200 feet west of Bergen Point light	40 38 35	74 08 58	20	Ebb	23.0	32	4.09	74
858	12.20	At 1st drawbridge C. R.R. of N. J.	40 39 17	74 08 46	1	Ebb	23.5	36	4.43	82
859	12.21	At 1st drawbridge C. R.R. of N. J.	40 39 17	74 08 46	20	Ebb	23.0	34	4.43	81
860	12.40	By bell buoy 2 above 1st drawbridge	40 40 12	74 08 05	1	Ebb	23.5	46	4.26	76
861	12.41	By bell buoy 2 above 1st drawbridge	40 40 12	74 08 05	20	Ebb	23.5	46	4.26	76
862	1.00	By nun buoy 4 below 2d drawbridge	40 41 38	74 07 25	1	Ebb	23.5	46	3.03	54
863	1.01	By nun buoy 4 below 2d drawbridge	40 41 38	74 07 25	8	Ebb	23.5	46	3.03	54
864	1.10	At 2d drawbridge, L. V. R.R.	40 41 56	74 07 12	1	Ebb	24.0	60	1.92	34
865	1.11	At 2d drawbridge, L. V. R.R.	40 41 56	74 07 12	10	Ebb	24.0	60	1.92	34
866	1.20	By nun buoy just below mouth of Passaic river	40 42 28	74 07 12	1	Ebb	24.5	68	1.35	24
867	1.21	By nun buoy just below mouth of Passaic river	40 42 28	74 07 12	15	Ebb	24.5	64	1.35	24

TABLE XXVII—Continued

40—PASSAIC RIVER. AUGUST 8, 1911

Low water at Newark at 2 P. M.

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
868	1.30	At C. R.R. of N. J. drawbridge just above mouth of Passaic river......	40 43 21	74 07 18	1	Ebb	25.0	82	0.00	0
869	1.31	At C. R.R. of N. J. drawbridge just above mouth of Passaic river.......	40 43 21	74 07 18	15	Ebb	25.0	80	0.00	0
870	1.40	At Plank road drawbridge...........	40 43 58	74 07 06	1	Ebb	26.0	88	0.00	0
871	1.41	At Plank road drawbridge...........	40 43 58	74 07 06	15	Ebb	25.5	88	0.00	0
872	1.50	At Penn. R.R. freight bridge just below Newark......................	40 44 06	74 09 45	1	Ebb	26.0	96	0.00	0
873	1.51	At Penn. R.R. freight bridge just below Newark........................	40 44 06	47 09 45	12	Ebb	26.0	96	0.00	0
874	2.00	At Penn. R.R. passenger bridge at Newark........................	40 44 49	74 09 56	1	Ebb	26.0	98	0.00	0
875	2.01	At Penn. R.R. passenger bridge at Newark........................	40 44 49	74 09 56	12	Ebb	26.0	98	0.00	0

41—THE NARROWS CROSS-SECTION BETWEEN FORT WADSWORTH, S. I., AND FORT LAFAYETTE. AUGUST 9, 1911

High water at Governor's Island at 7.43 A. M. Low water at 2.07 P. M.

876	A. M. 9.40	500 feet off Fort Wadsworth.........	40 36 22	74 02 08	1	Ebb	23.0	28	4.00	73
877	9.42	500 feet off Fort Wadsworth.........	40 36 22	74 02 08	40	Ebb	22.0	22	4.26	77
878	9.44	500 feet off Fort Wadsworth.........	40 36 22	74 02 08	75	Ebb	22.0	22	4.26	77
879	9.50	Midway between forts...............	40 36 25	74 02 48	1	Ebb	23.0	28	4.09	74
880	9.52	Midway between forts...............	40 36 25	74 02 48	40	Ebb	22.0	22	4.38	80
881	9.54	Midway between forts...............	40 36 25	74 02 48	75	Ebb	22.0	22	4.38	80
882	10.00	500 feet off Fort Lafayette...........	40 36 28	74 02 27	1	Ebb	23.0	28	4.12	75
883	10.02	500 feet off Fort Lafayette...........	40 36 28	74 02 27	40	Ebb	22.0	22	4.42	80
884	10.04	500 feet off Fort Lafayette...........	40 36 28	74 02 27	75	Ebb	22.0	22	4.42	80
885	11.40	500 feet off Fort Wadsworth.........	40 36 22	74 03 08	1	Ebb	23.0	28	3.43	62
886	11.42	500 feet off Fort Wadsworth.........	40 36 22	74 03 08	40	Ebb	22.0	22	3.72	68
887	11.44	500 feet off Fort Wadsworth.........	40 36 22	74 03 08	75	Ebb	22.0	22	3.72	68
888	12.00	Midway between forts...............	40 36 25	74 02 48	1	Ebb	23.0	28	3.57	65
889	P. M. 12.02	Midway between forts...............	40 36 25	74 02 48	40	Ebb	22.0	24	3.70	67
890	12.04	Midway between forts...............	40 36 25	74 02 48	75	Ebb	22.0	24	3.70	67
891	12.10	500 feet off Fort Lafayette...........	40 36 28	74 02 27	1	Ebb	23.0	28	3.53	64
892	12.12	500 feet off Fort Lafayette............	40 36 28	74 02 27	40	Ebb	22.0	24	3.83	70
893	12.14	500 feet off Fort Lafayette...........	40 36 28	74 02 27	75	Ebb	22.0	24	3.83	70
894	1.10	500 feet off Fort Wadsworth..........	40 36 22	74 03 08	1	Ebb	23.5	28	3.43	62
895	1.12	500 feet off Fort Wadsworth..........	40 36 22	74 03 08	40	Ebb	23.0	24	3.72	68
896	1.14	500 feet off Fort Wadsworth..........	40 36 22	74 03 08	75	Ebb	23.0	24	3.72	68
897	1.20	Midway between forts...............	40 36 25	74 02 48	1	Ebb	23.5	28	3.57	65
898	1.22	Midway between forts...............	40 36 25	74 02 48	40	Ebb	23.0	24	3.70	67
899	1.24	Midway between forts...............	40 36 25	74 02 48	75	Ebb	23.0	24	3.70	67
900	1.30	500 feet off Fort Lafayette...........	40 36 28	74 02 27	1	Ebb	23.5	28	3.53	64
901	1.32	500 feet off Fort Lafayette...........	40 36 28	74 02 27	40	Ebb	23.0	24	3.68	64
902	1.34	500 feet off Fort Lafayette...........	40 36 28	74 02 27	75	Ebb	23.0	24	3.68	67

TABLE XXVII—Continued

42—HUDSON RIVER CROSS-SECTION FROM PIER A, MANHATTAN, TO C. R.R. OF N. J. FERRY, JERSEY CITY. AUGUST 10, 1911

High water at Governor's Island at 8.23 A. M. Low water at 2.27 P. M.

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
903	9.10	100 feet off Pier A	40 42 16	74 01 09	1	Flood	23.0	32	2.97	54
904	9.11	100 feet off Pier A	40 42 16	74 01 09	20	Flood	22.0	30	3.10	56
905	9.13	100 feet off Pier A	40 42 16	74 01 09	40	Flood	22.0	30	3.10	56
906	9.17	¼ way across from Pier A	40 42 17	74 01 20	1	Flood	23.0	32	3.03	55
907	9.18	¼ way across from Pier A	40 42 17	74 01 20	20	Flood	22.0	30	3.17	58
908	9.20	¼ way across from Pier A	40 42 17	74 01 20	40	Flood	22.0	30	3.17	58
909	9.24	Midstream	40 42 19	74 01 34	1	Flood	23.0	32	3.09	56
910	9.25	Midstream	40 42 19	74 01 34	20	Flood	22.0	30	3.24	59
911	9.27	Midstream	40 42 19	74 01 34	40	Flood	22.0	30	3.24	59
912	9.30	¾ way across from Pier A	40 42 21	74 01 48	1	Flood	23.0	32	3.14	57
913	9.31	¾ way across from Pier A	40 42 21	74 01 48	20	Flood	22.0	30	3.29	60
914	9.33	¾ way across from Pier A	40 42 21	74 01 48	35	Flood	22.0	30	3.29	60
915	9.37	100 feet off C. R.R. of N. J. ferry	40 42 22	74 01 59	1	Flood	23.0	32	3.01	55
916	9.38	100 feet off C. R.R. of N. J. ferry	40 42 22	74 01 59	20	Flood	22.0	30	3.15	57
917	9.40	100 feet off C. R.R. of N. J. ferry	40 42 22	74 01 59	28	Flood	22.0	30	3.15	57
918	11.10	100 feet off Pier A	40 42 16	74 01 09	1	Ebb	23.0	34	2.70	49
919	11.11	100 feet off Pier A	40 42 16	74 01 09	20	Ebb	22.0	32	2.81	51
920	11.13	100 feet off Pier A	40 42 16	74 01 09	40	Ebb	22.0	32	2.81	51
921	11.17	¼ way across from Pier A	40 42 17	74 01 20	1	Ebb	23.0	34	2.90	53
922	11.18	¼ way across from Pier A	40 42 17	74 01 20	20	Ebb	22.0	32	2.90	53
923	11.20	¼ way across from Pier A	40 42 17	74 01 20	40	Ebb	22.0	32	2.90	53
924	11.24	Midstream	40 42 19	74 01 34	1	Ebb	23.0	34	2.95	55
925	11.25	Midstream	40 42 19	74 01 34	20	Ebb	22.0	32	2.95	55
926	11.27	Midstream	40 42 19	74 01 34	40	Ebb	22.0	32	2.95	55
927	11.30	¾ way across from Pier A	40 42 21	74 01 48	1	Ebb	23.0	34	2.86	52
928	11.31	¾ way across from Pier A	40 42 21	74 01 48	20	Ebb	22.0	32	3.00	55
929	11.33	¾ way across from Pier A	40 42 21	74 01 48	35	Ebb	22.0	32	3.00	55
930	11.37	100 feet off C. R.R. of N. J. ferry	40 42 22	74 01 59	1	Ebb	23.0	34	2.74	50
931	11.38	100 feet off C. R.R. of N. J. ferry	40 42 22	74 01 59	20	Ebb	22.0	32	2.88	52
932	11.40	100 feet off C. R.R. of N. J. ferry	40 42 22	74 01 59	28	Ebb	22.0	32	2.88	52
	P. M.									
933	1.30	100 feet off Pier A	40 42 16	74 01 09	1	Ebb	23.0	36	2.70	49
934	1.31	100 feet off Pier A	40 42 16	74 01 09	20	Ebb	22.0	32	2.81	51
935	1.33	100 feet off Pier A	40 42 16	74 01 09	40	Ebb	22.0	32	2.81	51
936	1.37	¼ way across from Pier A	40 42 17	74 01 20	1	Ebb	23.0	36	2.76	50
937	1.38	¼ way across from Pier A	40 42 17	74 01 20	20	Ebb	22.0	32	2.90	53
938	1.40	¼ way across from Pier A	40 42 17	74 01 20	40	Ebb	22.0	32	2.90	53
939	1.44	Midstream	40 42 19	74 01 34	1	Ebb	23.0	36	2.80	51
940	1.45	Midstream	40 42 19	74 01 34	20	Ebb	22.0	32	2.95	55
941	1.47	Midstream	40 42 19	74 01 34	40	Ebb	22.0	32	2.95	55
942	1.50	¾ way across from Pier A	40 42 21	74 01 48	1	Ebb	23.0	36	2.72	50
943	1.51	¾ way across from Pier A	40 42 21	74 01 48	20	Ebb	22.0	32	2.86	52
944	1.51	¾ way across from Pier A	40 42 21	74 01 48	35	Ebb	22.0	32	2.86	52
945	1.57	100 feet off C. R.R. of N. J. ferry	40 42 22	74 01 59	1	Ebb	23.0	36	2.60	47
946	1.58	100 feet off C. R.R. of N. J. ferry	40 42 22	74 01 59	20	Ebb	22.0	32	2.74	50
947	2.00	100 feet off C. R.R. of N. J. ferry	40 42 22	74 01 59	28	Ebb	22.0	32	2.74	50

TABLE XXVII—Continued

43—GOWANUS CANAL. AUGUST 10, 1911

High water at Governor's Island at 8.23 A. M. Low water at 2.27 P. M.

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
948	2.35	At Hamilton Avenue Bridge..........	40 40 17	73 59 56	1	Ebb	23.5	30	0.81	15
949	2.36	At Hamilton Avenue Bridge..........	40 40 17	73 59 56	15	Ebb	23.0	30	1.32	24
950	2.45	At mouth, 25th street, Brooklyn......	40 39 55	74 00 25	1	Ebb	23.5	30	2.29	42
951	2.46	At mouth, 25th street, Brooklyn......	40 39 55	74 00 25	15	Ebb	23.0	30	2.29	42

44—COURSE FROM NEW YORK TO NEW LONDON, CONN., BY LONG ISLAND SOUND. AUGUST 17, 1911

High water occurred at Governor's Island, N. Y., at 12.20 P. M. Samples collected and tests made on boat Quadrant II.

	A. M.									
952	5.00	East river, midstream, off East 42d street, New York................	40 44 47	73 57 49	1	Ebb	22.0	28	2.76	51
953	5.01	East river, midstream, off East 42d street, New York.................	40 44 47	73 57 49	20	Ebb	22.0	26	2.76	51
954	5.03	East river, midstream, off East 42d street, New York.................	40 44 47	73 57 49	40	Ebb	22.0	26	2.76	51
955	6.00	East river, midway between Clason Point and College Point...........	40 48 00	73 51 11	1	Ebb	22.0	24	3.95	73
956	6.01	East river, midway between Clason Point and College Point...........	40 48 00	73 51 11	20	Ebb	22.0	24	3.95	73
957	6.03	East river, midway between Clason Point and College Point...........	40 48 00	73 51 11	40	Ebb	22.0	24	3.95	73
958	6.40	East river, midway between Throgs Neck and Willet's Point...........	40 48 00	73 47 13	1	Ebb	22.0	24	4.35	81
959	6.41	East river, midway between Throgs Neck and Willet's Point...........	40 48 00	73 47 13	30	Ebb	22.0	22	4.35	81
960	6.43	East river, midway between Throgs Neck and Willet's Point...........	40 48 00	73 47 13	60	Ebb	22.0	22	4.35	81
961	7.15	Long Island Sound, just north of Stepping Stones lighthouse.............	40 49 35	73 46 35	1	Ebb	22.0	22	4.64	86
962	7.16	Long Island Sound, just north of Stepping Stones lighthouse.............	40 49 35	73 46 35	20	Ebb	22.0	20	4.64	86
963	7.18	Long Island Sound, just north of Stepping Stones lighthouse.............	40 49 35	73 46 35	40	Ebb	22.0	20	4.64	86
964	7.45	Long Island Sound, just south of Execution Rocks lighthouse...........	40 52 30	73 44 15	1	Ebb	22.0	20	5.22	97
965	7.46	Long Island Sound, just south of Execution Rocks lighthouse...........	40 52 30	73 44 15	20	Ebb	21.5	20	5.22	97
966	7.48	Long Island Sound, just south of Execution Rocks lighthouse...........	40 52 30	73 44 15	35	Ebb	21.5	20	5.22	97
967	8.20	Long Island Sound, 1 mile north of Matinicock Point, L. I............	40 54 55	73 38 10	1	Ebb	22.0	20	5.40	100
968	8.21	Long Island Sound, 1 mile north of Matinicock Point, L. I............	40 54 55	73 38 10	25	Ebb	21.5	20	5.40	100
969	8.23	Long Island Sound, 1 mile north of Matinicock Point, L. I............	40 54 55	73 38 10	50	Ebb	21.5	20	5.40	100
970	9.20	Long Island Sound, just north of bell buoy off Lloyd Point, L. I.........	41 57 45	73 29 15	1	Ebb	22.0	20	5.40	100
971	9.21	Long Island Sound, just north of bell buoy off Lloyd Point, L. I.........	41 57 45	73 29 15	25	Ebb	21.5	20	5.40	100
972	9.23	Long Island Sound, just north of bell buoy off Lloyd Point, L. I.........	41 57 45	73 29 15	50	Ebb	21.5	20	5.40	100
973	9.50	Long Island Sound, near red and black buoy off Eaton's Point, L. I........	41 58 45	73 24 40	1	Ebb	22.0	20	5.40	100

TABLE XXVII—Continued

44—COURSE FROM NEW YORK TO NEW LONDON, CONN., BY LONG ISLAND SOUND. AUGUST 17, 1911—Continued

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
974	9.51	Long Island Sound, near red and black buoy off Eaton's Point, L. I.	41 58 45	73 24 40	20	Ebb	21.5	20	5.40	100
975	9.53	Long Island Sound, near red and black buoy off Eaton's Point, L. I.	41 58 45	73 24 40	40	Ebb	21.5	20	5.40	100
976	11.45	Long Island Sound, by red buoy, near Shatford Shoals lighthouse	41 03 15	73 06 10	1	Flood	21.5	16	5.40	100
977	11.46	Long Island Sound, by red buoy, near Shatford Shoals lighthouse	41 03 15	73 06 10	20	Flood	21.0	16	5.40	100
978	11.48	Long Island Sound, by red buoy, near Shatford Shoals lighthouse	41 03 15	73 06 10	40	Flood	21.0	16	5.40	100
979	P. M. 12.45	Long Island Sound, 7 miles north of Rocky Point between Miller's and Hallock's landing	41 04 00	72 57 25	1	Flood	21.5	16	5.40	100
980	12.46	Long Island Sound, 7 miles north of Rocky Point, between Miller's and Hallock's landing	41 04 00	72 57 25	40	Flood	21.0	16	5.40	100
981	12.48	Long Island Sound, 7 miles north of Rocky Point, between Miller's and Hallock's landing	41 04 00	72 57 25	80	Flood	21.0	16	5.40	100
982	2.30	Long Island Sound, 4 miles south of Falkner Island, Conn.	41 09 15	72 39 00	1	Flood	21.5	16	5.40	100
983	2.31	Long Island Sound, 4 miles south of Falkner Island, Conn.	41 09 15	72 39 00	40	Flood	21.0	16	5.40	100
984	2.33	Long Island Sound, 4 miles south of Falkner Island, Conn.	41 09 15	72 39 00	80	Flood	21.0	16	5.40	100
985	4.25	Long Island Sound, near Cornfield Point lightship	41 12 40	72 22 40	1	Flood	21.0	11	5.40	100
986	4.26	Long Island Sound, near Cornfield Point lightship	41 12 40	72 22 40	50	Flood	20.5	10	5.40	100
987	4.28	Long Island Sound, near Cornfield Point lightship	41 12 40	72 22 40	100	Flood	20.5	10	5.40	100
988	6.00	Long Island Sound, near Bartlett Reef lightship, off New London, Conn.	41 16 15	72 08 50	1	Ebb	21.0	10	5.40	100
989	6.01	Long Island Sound, near Bartlett Reef lightship, off New London, Conn.	41 16 15	72 08 50	25	Ebb	20.5	10	5.40	100
990	6.03	Long Island Sound, near Bartlett Reef lightship, off New London, Conn.	41 16 15	72 08 50	50	Ebb	20.5	10	5.40	100

45—COURSE FROM NEW LONDON, CONN., TO VINEYARD HAVEN, MASS. AUGUST 18, 1911

High water at New London at 3.13 A. M. Left New London 5.25 A. M. on boat Quadrant II.

991	A. M. 6.15	Fisher Island Sound, by Ram Island lightship	41 18 00	71 58 35	1	Ebb	20.0	8	5.40	100
992	6.16	Fisher Island Sound, by Ram Island lightship	41 18 00	71 58 35	25	Ebb	20.0	8	5.40	100
993	6.18	Fisher Island Sound, by Ram Island lightship	41 18 00	71 58 35	50	Ebb	20.0	8	5.40	100
994	6.50	Block Island Sound, by bell buoy just off Watch Hill Point	41 17 45	71 51 50	1	Ebb	20.0	8	5.40	100
995	6.51	Block Island Sound, by bell buoy just off Watch Hill Point	41 17 45	71 51 50	20	Ebb	20.0	8	5.40	100
996	6.53	Block Island Sound, by bell buoy just off Watch Hill Point	41 17 45	71 51 50	40	Ebb	20.0	8	5.40	100
997	7.40	Block Island Sound, 1 mile south of Noyes Point	41 18 45	71 45 00	1	Ebb	20.0	8	5.40	100

TABLE XXVII—Continued

45—COURSE FROM NEW LONDON, CONN., TO VINEYARD HAVEN, MASS. AUGUST 18, 1911—Continued

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Pwe cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
998	7.41	Block Island Sound, 1 mile south of Noyes Point	41 18 45	71 45 00	30	Ebb	20.0	8	5.40	100
999	7.43	Block Island Sound, 1 mile south of Noyes Point	41 18 45	71 45 00	60	Ebb	20.0	8	5.40	100
1000	9.00	Atlantic ocean, by whistling buoy off Point Judith, R. I.	41 20 30	71 28 30	1	Ebb	20.0	8	5.40	100
1001	9.01	Atlantic ocean, by whistling buoy off Point Judith, R. I.	41 20 30	71 28 30	20	Ebb	20.0	8	5.40	100
1002	9.03	Atlantic ocean, by whistling buoy off Point Judith, R. I.	41 20 30	71 28 30	40	Ebb	20.0	8	5.40	100
1003	11.50	Atlantic ocean, near Vineyard Sound lightship	41 22 40	71 00 00	1	Ebb	19.5	6	5.40	100
1104	11.51	Atlantic ocean, near Vineyard Sound lightship	41 22 40	71 00 00	40	Ebb	19.5	6	5.40	100
1105	11.53	Atlantic ocean, near Vineyard Sound lightship	41 22 40	71 00 00	80	Ebb	19.5	6	5.40	100
	P. M.									
1006	1.00	Vineyard Sound, by bell buoy north of Gay Head, Martha's Vineyard	71 24 15	70 51 20	1	Ebb	19.5	6	5.40	100
1007	1.01	Vineyard Sound, by bell buoy north of Gay Head, Martha's Vineyard	71 24 15	70 51 20	25	Ebb	19.5	6	5.40	100
1008	1.03	Vineyard Sound, by bell buoy north of Gay Head, Martha's Vineyard	71 24 15	70 51 20	50	Ebb	19.5	6	5.40	100
1009	2.00	Vineyard Sound, by bell buoy off Nobska Point, near Wood's Hole	41 30 20	70 38 40	1	Flood	20.0	6	5.40	100
1010	2.01	Vineyard Sound, by bell buoy off Nobska Point, near Wood's Hole	41 30 20	70 38 40	30	Flood	20.0	6	5.40	100
1011	2.03	Vineyard Sound, by bell buoy off Nobska Point, near Wood's Hole	41 30 20	70 38 40	60	Flood	20.0	6	5.40	100
1012	2.30	Vineyard Haven, at entrance to harbor	41 28 45	70 35 25	1	Flood	20.5	6	5.40	100
1013	2.31	Vineyard Haven, at entrance to harbor	41 28 45	70 35 25	30	Flood	20.0	6	5.40	100
1014	2.33	Vineyard Haven, at entrance to harbor	41 28 45	70 35 25	60	Flood	20.0	6	5.40	100
1015	3.00	At Lord's Wharf, Vineyard Haven, Mass	41 27 15	70 36 00	1	Flood	21.0	6	5.40	100
1016	3.01	At Lord's Wharf, Vineyard Haven, Mass	41 27 15	70 36 00	10	Flood	21.0	6	5.40	100

46—COURSE FROM VINEYARD HAVEN, MASS., TO PROVINCETOWN, MASS., AROUND CAPE COD. AUGUST 20, 1911

High water at Vineyard Haven at 7.30 A. M. Very high N. W. wind amounting to a gale blew from 10 P. M., August 18, to 3 P. M., August 19. Held boat in Vineyard Haven harbor.

	A. M.									
1017	5.00	At Lord's Wharf, Vineyard Haven	41 27 15	70 36 00	1	Flood	20.5	6	5.40	100
1018	5.01	At Lord's Wharf, Vineyard Haven	41 27 15	70 36 00	10	Flood	20.5	6	5.40	100
1019	5.10	Vineyard Haven, at entrance to harbor	41 28 45	70 35 25	1	Flood	20.5	6	5.40	100
1020	5.11	Vineyard Haven, at entrance to harbor	41 28 45	70 35 25	20	Flood	20.0	6	5.40	100
1021	5.13	Vineyard Haven, at entrance to harbor	41 28 45	70 35 25	60	Flood	20.0	6	5.40	100
1022	5.23	Vineyard Sound, ½ mile off dock at Oak Bluffs (Cottage City)	41 28 20	70 34 45	1	Flood	20.5	6	5.40	100
1023	5.24	Vineyard Sound, ½ mile off dock at Oak Bluffs (Cottage City)	41 28 20	70 34 45	20	Flood	20.0	6	5.40	100
1024	5.26	Vineyard Sound, ½ mile off dock at Oak Bluffs (Cottage City)	41 28 20	70 34 45	45	Flood	20.0	6	5.40	100
1025	6.00	Atlantic ocean, near Hedge Fence lightship	41 28 20	70 29 00	1	Flood	19.5	4	5.40	100

TABLE XXVII—Continued

46—COURSE FROM VINEYARD HAVEN, MASS., TO PROVINCETOWN, MASS., AROUND CAPE COD. AUGUST 20, 1911—Continued

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
1026	6.01	Atlantic ocean, near Hedge Fence lightship	41 28 20	70 29 00	25	Flood	19.0	4	5.40	100
1027	6.03	Atlantic ocean, near Hedge Fence lightship	41 28 20	70 29 00	50	Flood	19.0	4	5.40	100
1028	7.00	Atlantic ocean, near Cross Rip lightship	41 26 50	70 17 25	1	Flood	19.5	4	5.40	100
1029	7.01	Atlantic ocean, near Cross Rip lightship	41 26 50	70 17 25	25	Flood	19.0	4	5.40	100
1030	7.03	Atlantic ocean, near Cross Rip lightship	41 26 50	70 17 25	50	Flood	19.0	4	5.40	100
1031	8.20	Atlantic ocean, near Handkerchief lightship	41 29 15	70 04 00	1	Ebb	18.0	4	5.54	100
1032	8.21	Atlantic ocean, near Handkerchief lightship	41 29 15	70 04 00	15	Ebb	18.0	4	5.54	100
1033	8.23	Atlantic ocean, near Handkerchief lightship	41 29 15	70 04 00	30	Ebb	18.0	4	5.54	100
1034	9.10	Atlantic ocean, near Shovelfull lightship, off Monomoy Beach, Cape Cod	41 32 40	69 59 40	1	Ebb	18.0	4	5.54	100
1035	9.11	Atlantic ocean, near Shovelfull lightship, off Monomoy Beach, Cape Cod	41 32 40	69 59 40	25	Ebb	17.0	4	5.54	100
1036	9.13	Atlantic ocean, near Shovelfull lightship, off Monomoy Beach, Cape Cod	41 32 40	69 59 40	50	Ebb	17.0	4	5.54	100
1037	9.45	Atlantic ocean, near Pollock Rip lightship	41 32 00	69 54 40	1	Ebb	17.0	4	5.68	100
1038	9.46	Atlantic ocean, near Pollock Rip lightship	41 32 00	69 54 40	15	Ebb	17.0	4	5.68	100
1039	9.48	Atlantic ocean, near Pollock Rip lightship	41 32 00	69 54 40	30	Ebb	17.0	4	5.68	100
1040	10.15	Atlantic ocean, near Pollock Rip Shoals lightship	41 36 35	69 53 50	1	Ebb	17.0	4	5.68	100
1041	10.16	Atlantic ocean, near Pollock Rip Shoals lightship	41 36 35	69 53 50	20	Ebb	17.0	4	5.68	100
1042	10.18	Atlantic ocean, near Pollock Rip Shoals lightship	41 36 35	69 53 50	40	Ebb	17.0	4	5.68	100
1043	11.15	Atlantic ocean, 4 miles east of Chatham lighthouse	41 41 00	69 52 10	1	Ebb	17.0	4	5.68	100
1044	11.16	Atlantic ocean, 4 miles east of Chatham lighthouse	41 41 00	69 52 10	25	Ebb	17.0	4	5.68	100
1045	11.18	Atlantic ocean, 4 miles east of Chatham lighthouse	41 41 00	69 52 10	50	Ebb	17.0	4	5.68	100
1046	P. M. 12.45	Atlantic ocean, 1½ miles off Nansset lighthouses, Cape Cod	41 51 50	69 55 25	1	Ebb	17.0	4	5.68	100
1047	12.46	Atlantic ocean, 1½ miles off Nansset lighthouses, Cape Cod	41 51 50	69 55 25	35	Ebb	17.0	4	5.68	100
1048	12.48	Atlantic ocean, 1½ miles off Nansset lighthouses, Cape Cod	41 51 50	69 55 25	70	Ebb	17.0	4	5.68	100
1049	2.30	Atlantic ocean, 1 mile off Highland light, Cape Cod	42 02 45	70 02 35	1	Flood	17.0	4	5.68	100
1050	2.31	Atlantic ocean, 1 mile off Highland light, Cape Cod	42 02 45	70 02 35	30	Flood	17.0	4	5.68	100
1051	2.33	Atlantic ocean, 1 mile off Highland light, Cape Cod	42 02 45	70 02 35	60	Flood	17.0	4	5.68	100
1052	3.30	Cape Cod bay, by white buoy off Race Point, Provincetown	42 02 45	70 15 05	1	Flood	18.0	6	5.68	100
1053	3.32	Cape Cod bay, by white buoy off Race Point, Provincetown	42 02 45	70 15 05	50	Flood	17.0	6	5.68	100

TABLE XXVII—Continued

46—COURSE FROM VINEYARD HAVEN, MASS., TO PROVINCETOWN, MASS., AROUND CAPE COD. AUGUST 20, 1911—Continued

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
1054	3.34	Cape Cod bay, by white buoy off Race Point, Provincetown	42 02 45	70 15 05	100	Flood	17.0	6	5.68	100
1055	4.15	Cape Cod bay, by bell buoy off Long Point light, just outside Provincetown	42 01 50	70 09 45	1	Flood	18.0	6	5.68	100
1056	4.16	Cape Cod bay, by bell buoy off Long Point light, just outside Provincetown	42 01 50	70 09 45	30	Flood	17.0	6	5.68	100
1057	4.18	Cape Cod bay, by bell buoy off Long Point light, just outside Provincetown	42 01 50	70 09 45	60	Flood	17.0	6	5.68	100

47—COURSE FROM PROVINCETOWN TO BOSTON, MASS. AUGUST 21, 1911

High water at Provincetown at 8.25 A. M. High water at Boston at 8.25 A. M.

	A. M.									
1058	5.00	Provincetown harbor, 1 mile north of Long Point lighthouse	42 02 45	70 10 20	1	Flood	18.5	6	5.68	100
1059	5.01	Provincetown harbor, 1 mile north of Long Point lighthouse	42 02 45	70 10 20	20	Flood	18.0	5	5.68	100
1060	5.03	Provincetown harbor, 1 mile north of Long Point lighthouse	42 02 45	70 10 20	40	Flood	18.0	5	5.68	100
1061	6.05	Cape Cod bay, by white buoy off Race Point, outside Provincetown	42 02 45	70 15 05	1	Flood	18.0	5	5.68	100
1062	6.06	Cape Cod bay, by white buoy off Race Point, outside Provincetown	42 02 45	70 15 05	50	Flood	18.0	4	5.68	100
1063	6.08	Cape Cod bay, by white buoy off Race Point, outside Provincetown	42 02 45	70 15 05	100	Flood	18.0	4	5.68	100
1064	6.45	Massachusetts bay, 2 miles northwest of Race Point, Cape Cod	42 04 35	70 16 35	1	Flood	18.5	4	5.68	100
1065	6.46	Massachusetts bay, 2 miles northwest of Race Point, Cape Cod	42 04 35	70 16 35	50	Flood	18.0	4	5.68	100
1066	6.48	Massachusetts bay, 2 miles northwest of Race Point, Cape Cod	42 04 35	70 16 35	100	Flood	18.0	4	5.68	100
1067	10.00	Massachusetts bay, by black buoy 2 miles off Minots' ledge light	42 16 40	70 42 20	1	Ebb	18.5	6	5.54	100
1068	10.01	Massachusetts bay, by black buoy 2 miles off Minots' ledge light	42 16 40	70 42 20	25	Ebb	18.5	6	5.54	100
1069	10.03	Massachusetts bay, by black buoy 2 miles off Minots' ledge light	42 16 40	70 42 20	50	Ebb	18.5	6	5.54	100
1070	11.00	Massachusetts bay, 1 mile southeast of Boston light	42 19 15	70 52 25	1	Ebb	18.5	6	5.54	100
1071	11.01	Massachusetts bay, 1 mile southeast of Boston light	42 19 15	70 52 25	20	Ebb	18.5	6	5.54	100
1072	11.03	Massachusetts bay, 1 mile southeast of Boston light	42 19 15	70 52 25	40	Ebb	18.5	6	5.54	100
1073	11.20	Boston harbor, The Narrows, between Lovells Island and Gallups Island	42 19 35	70 55 55	1	Ebb	19.5	6	5.47	100
1074	11.21	Boston harbor, The Narrows, between Lovells Island and Gallups Island	42 19 35	70 55 55	15	Ebb	19.0	6	5.47	100
1075	11.23	Boston harbor, The Narrows, between Lovells Island and Gallups Island	42 19 35	70 55 55	30	Ebb	19.0	6	5.47	100
1076	11.45	Midway between Governor's Island and Castle Island	42 20 42	71 00 42	1	Ebb	19.5	6	5.11	95
1077	11.46	Midway between Governor's Island and Castle Island	42 20 42	71 00 42	15	Ebb	19.0	6	5.28	98

TABLE XXVII—Continued

47—COURSE FROM PROVINCETOWN TO BOSTON, MASS. AUGUST 21, 1911—Continued

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
1078	11.48	Midway between Governor's Island and Castle Island	42 20 42	71 00 42	30	Ebb	19.0	6	5.28	98
	P. M.									
1079	12.15	Midway between East Boston docks and entrance to South bay	42 21 39	71 02 35	1	Ebb	19.5	6	4.93	91
1080	12.16	Midway between East Boston docks and entrance to South bay	42 21 39	71 02 35	15	Ebb	19.0	6	5.07	94
1081	12.17	Midway between East Boston docks and entrance to South bay	42 21 39	71 02 35	30	Ebb	19.0	6	5.07	94
1082	12.40	Charles river, near mouth, just below last drawbridge	42 22 07	71 03 30	1	Ebb	19.5	10	2.27	42
1083	12.41	Charles river, near mouth, just below last drawbridge	42 22 07	71 03 30	10	Ebb	19.0	8	3.41	63
1084	12.43	Charles river, near mouth, just below last drawbridge	42 22 07	71 03 30	20	Ebb	19.0	8	3.41	63

48—BOSTON HARBOR. INNER HARBOR TO SOUTH CHANNEL IN OUTER HARBOR. AUGUST 23, 1911

High water at Boston at 10.30 A. M. Low water at 4.30 P. M.

	A. M.									
1085	9.10	Boston inner harbor, midway between East Boston docks and entrance to South Bay, Boston	42 21 39	71 02 35	1	Flood	19.5	6	5.40	100
1086	9.11	Boston inner harbor, midway between East Boston docks and entrance to South Bay, Boston	42 21 39	71 02 35	15	Flood	19.5	6	5.40	100
1087	9.13	Boston inner harbor, midway between East Boston docks and entrance to South Bay, Boston	42 21 39	71 02 35	30	Flood	19.5	6	5.40	100
1088	9.23	Boston inner harbor, by red buoy 10, midway between Governor's Island and East Boston docks	42 21 35	71 01 10	1	Flood	19.5	6	5.40	100
1089	9.24	Boston inner harbor, by red buoy 10, midway between Governor's Island and East Boston docks	42 21 35	71 01 10	10	Flood	19.0	6	5.40	100
1090	9.26	Boston inner harbor, by red buoy 10, midway between Governor's Island and East Boston docks	42 21 35	71 01 10	15	Flood	19.0	6	5.40	100
1091	9.36	Boston inner harbor, midway between Governor's Island and Castle Island	42 20 42	71 00 42	1	Flood	19.5	6	5.28	98
1092	9.37	Boston inner harbor, midway between Governor's Island and Castle Island	42 20 42	71 00 42	15	Flood	19.0	6	5.40	100
1093	9.39	Boston inner harbor, midway between Governor's Island and Castle Island	42 20 42	71 00 42	30	Flood	19.0	6	5.40	100
1094	9.55	Boston outer harbor, midway between Deer Island light and Governor's Island	42 20 36	70 58 45	1	Flood	19.5	6	5.40	100
1095	9.56	Boston outer harbor, midway between Deer Island light and Governor's Island	42 20 36	70 58 45	10	Flood	19.0	6	5.40	100
1096	9.58	Boston outer harbor, midway between Deer Island light and Governor's Island	42 20 36	70 58 45	20	Flood	19.0	6	5.40	100
1097	10.18	Boston outer harbor, midway between Deer Island light and Long Island light	42 20 06	70 57 13	1	Flood	19.5	6	5.42	100

TABLE XXVII—Continued

48—BOSTON HARBOR. INNER HARBOR TO SOUTH CHANNEL IN OUTER HARBOR. AUGUST 23, 1911—Continued

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
1098	10.19	Boston outer harbor, midway between Deer Island light and Long Island light	42 20 06	70 57 13	30	Flood	19.0	4	5.42	100
1099	10.21	Boston outer harbor, midway between Deer Island light and Long Island light	42 20 06	70 57 13	60	Flood	19.0	4	5.42	100
1100	10.40	Boston outer harbor, by gas buoy 8, entrance to South channel (north of Lovell's Island)	42 20 34	70 56 04	1	Flood	18.0	4	5.47	100
1101	10.41	Boston outer harbor, by gas buoy 8, entrance to South channel (north of Lovell's Island)	42 20 34	70 56 04	20	Flood	17.0	4	5.47	100
1102	10.43	Boston outer harbor, by gas buoy 8, entrance to South channel (north of Lovell's Island)	42 20 34	70 56 04	40	Flood	17.0	4	5.47	100
1103	P. M. 3.00	Boston inner harbor, midway between East Boston docks and entrance to South bay, Boston	42 21 39	71 02 35	1	Ebb	19.5	6	4.51	84
1104	3.01	Boston inner harbor, midway between East Boston docks and entrance to South bay, Boston	42 21 39	71 02 35	15	Ebb	19.0	6	4.65	86
1105	3.03	Boston inner harbor, midway between East Boston docks and entrance to South bay, Boston	42 21 39	71 02 35	30	Ebb	19.0	6	4.65	86
1106	3.13	Boston inner harbor, by red buoy 10, midway between Governor's Island and East Boston docks	42 21 35	71 01 10	1	Ebb	19.5	6	4.93	91
1107	3.14	Boston inner harbor, by red buoy 10, midway between Governor's Island and East Boston docks	42 21 35	71 01 10	10	Ebb	19.0	6	5.07	94
1108	3.16	Boston inner harbor, by red buoy 10, midway between Governor's Island and East Boston docks	42 21 35	71 01 10	15	Ebb	19.0	6	5.07	94
1109	3.26	Midway between Governor's Island and Castle Island	42 20 42	71 00 42	1	Ebb	19.5	6	5.00	93
1110	3.27	Midway between Governor's Island and Castle Island	42 20 42	71 00 42	15	Ebb	19.0	6	5.14	95
1111	3.29	Midway between Governor's Island and Castle Island	42 20 42	71 00 42	30	Ebb	19.0	6	5.14	95
1112	3.45	Boston outer harbor, midway between Deer Island light and Governor's Island	42 20 36	70 58 45	1	Ebb	19.5	6	5.11	95
1113	3.46	Boston outer harbor, midway between Deer Island light and Governor's Island	42 20 36	70 58 45	10	Ebb	19.0	6	5.26	97
1114	3.48	Boston outer harbor, midway between Deer Island light and Governor's Island	42 20 36	70 58 45	20	Ebb	19.0	6	5.26	97
1115	4.10	Boston outer harbor, midway between Deer Island light and Long Island light	42 20 06	70 57 13	1	Ebb	19.5	6	5.40	100
1116	4.11	Boston outer harbor, midway between Deer Island light and Long Island light	42 20 06	70 57 13	30	Ebb	19.0	6	5.40	100
1117	4.13	Boston outer harbor, midway between Deer Island light and Long Island light	42 20 06	70 57 13	60	Ebb	19.0	6	5.40	100
1118	4.30	Boston outer harbor, by gas buoy 8, at entrance to South channel	42 20 34	70 56 04	1	Ebb	19.5	6	5.47	100
1119	4.31	Boston outer harbor, by gas buoy 8, at entrance to South channel	42 20 34	70 56 04	20	Ebb	19.0	6	5.47	100
1120	4.33	Boston outer harbor, by gas buoy 8, at entrance to South channel	42 20 34	70 56 04	40	Ebb	19.0	6	5.47	100

TABLE XXVII—Continued

249—BOSTON HARBOR, FROM INNER HARBOR TO SOUTH CHANNEL IN OUTER HARBOR. AUGUST 25, 1911

High water at Boston at 12.10 P. M. Low water at 6.00 p.m. Rain all day.

Sample No.	Hour A. M.	Location of Samples			Feet belo w surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude ° ′ ″	Longitude ° ′ ″					C. C. per litre	Per cent. saturation
1121	9.00	Boston inner harbor, midway between East Boston docks and entrance to South bay	42 21 39	71 02 35	1	Flood	19.5	6	5.00	93
1122	9.01	Boston inner harbor, midway between East Boston docks and entrance to South bay	42 21 39	71 02 35	15	Flood	19.0	6	5.26	97
1123	9.03	Boston inner harbor, midway between East Boston docks and entrance to South bay	42 21 39	71 02 35	30	Flood	19.0	6	5.26	97
1124	9.13	Boston inner harbor, by red buoy 10, midway between Governor's Island and East Boston docks	42 21 35	71 01 10	1	Flood	19.5	6	5.22	97
1125	9.14	Boston inner harbor, by red buoy 10, midway between Governor's Island and East Boston docks	42 21 35	71 01 10	10	Flood	19.0	6	5.36	99
1126	9.16	Boston inner harbor, by red buoy 10, midway between Governor's Island and East Boston docks	42 21 35	71 01 10	15	Flood	19.0	6	5.36	99
1127	9.26	Boston inner harbor, midway between Governor's Island and Castle Island	42 20 42	71 00 42	1	Flood	19.5	6	5.11	95
1128	9.27	Boston inner harbor, midway between Governor's Island and Castle Island	42 20 42	71 00 42	15	Flood	19.0	6	5.40	100
1129	9.29	Boston inner harbor, midway between Governor's Island and Castle Island	42 20 42	71 00 42	30	Flood	19.0	6	5.40	100
1130	9.45	Boston outer harbor, midway between Deer Island light and Governor's Island	42 20 36	70 58 45	1	Flood	19.5	6	5.42	100
1131	9.46	Boston outer harbor, midway between Deer Island light and Governor's Island	42 20 36	70 58 45	10	Flood	19.0	6	5.42	100
1132	9.48	Boston outer harbor, midway between Deer Island light and Governor's Island	42 20 36	70 58 45	20	Flood	19.0	6	5.42	100
1133	10.10	Boston outer harbor, midway between Deer Island light and Long Island light	42 20 06	70 57 13	1	Flood	19.5	6	5.40	100
1134	10.11	Boston outer harbor, midway between Deer Island light and Long Island light	42 20 06	70 57 13	30	Flood	19.0	4	5.40	100
1135	10.13	Boston outer harbor, midway between Deer Island light and Long Island light	42 20 06	70 57 13	60	Flood	19.0	4	5.40	100
1136	10.30	Boston outer harbor, by gas buoy 8, entrance to South channel	42 20 34	70 56 04	1	Flood	19.5	4	5.42	100
1137	10.31	Boston outer harbor, by gas buoy 8, entrance to South channel	42 20 34	70 56 04	15	Flood	19.0	4	5.42	100
1138	10.33	Boston outer harbor, by gas buoy 8, entrance to South channel	42 20 34	70 56 04	30	Flood	19.0	4	5.42	100
1139	P. M. 3.00	Boston inner harbor, midway between East Boston docks and entrance to South bay, Boston	42 21 39	71 02 35	1	Ebb	19.0	6	4.65	86
1140	3.01	Boston inner harbor, midway between East Boston docks and entrance to South bay, Boston	42 21 39	71 02 35	15	Ebb	19.0	6	4.78	89
1141	3.03	Boston inner harbor, midway between East Boston docks and entrance to South bay, Boston	42 21 39	71 02 35	30	Ebb	19.0	6	4.78	89
1142	3.13	Boston inner harbor, by red buoy 10, midway between Governor's Island and East Boston docks	42 21 35	71 01 10	1	Ebb	19.0	6	5.07	94

TABLE XXVII—Continued

49—BOSTON HARBOR, INNER HARBOR TO SOUTH CHANNEL IN OUTER HARBOR. AUGUST 25, 1911—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
1143	3.14	Boston inner harbor, by red buoy 10, midway between Governor's Island and East Boston docks	42 21 35	71 01 10	10	Ebb	19.0	6	5.22	97
1144	3.16	Boston inner harbor, by red buoy 10, midway between Governor's Island and East Boston docks	42 21 35	71 01 10	15	Ebb	19.0	6	5.22	97
1145	3.26	Boston inner harbor, midway between Governor's Island and Castle Island	42 20 42	71 00 42	1	Ebb	19.0	6	5.07	94
1146	3.27	Boston inner harbor, midway between Governor's Island and Castle Island	42 20 42	71 00 42	15	Ebb	19.0	6	5.22	97
1147	3.29	Boston inner harbor, midway between Governor's Island and Castle Island	42 20 42	71 00 42	30	Ebb	19.0	6	5.22	97
1148	3.48	Bpston outer harbor, midway between Deer Island light and Governor's Island	42 20 36	70 58 45	1	Ebb	19.0	6	5.26	97
1149	3.49	Boston outer harbor, midway between Deer Island light and Governor's Island	42 20 36	70 58 45	10	Ebb	19.0	6	5.40	100
1150	3.51	Boston outer harbor, midway between Deer Island light and Governor's Island	42 20 36	70 58 45	20	Ebb	19.0	6	5.40	100
1151	4.12	Boston outer harbor, midway between Deer Island light and Governor's Island	42 20 06	70 57 13	1	Ebb	19.0	6	5.40	100
1152	4.13	Boston outer harbor, midway between Deer Island light and Governor's Island	42 20 06	70 57 13	30	Ebb	19.0	6	5.40	100
1153	4.15	Boston outer harbor, midway between Deer Island light and Governor's Island	42 20 06	70 57 13	60	Ebb	19.0	6	5.40	100
1154	4.30	Boston outer harbor, by gas buoy 8 at entrance to South channel	42 20 34	70 56 04	1	Ebb	19.0	6	5.42	100
1155	4.31	Boston outer harbor, by gas buoy 8 at entrance to South channel	42 20 34	70 56 04	15	Ebb	19.0	4	5.42	100
1156	4.33	Boston outer harbor, by gas buoy 8 at entrance to South channel	42 20 34	70 56 04	30	Ebb	19.0	4	5.42	100

50—BOSTON INNER HARBOR AT CHARLES RIVER. AUGUST 28, 1911

High water at Boston at 2.28 P. M.

	A. M.									
1157	8.45	Charles river, midway between mouth and lowest bridge	42 22 15	71 03 18	1	Ebb	20.0	32	1.79	31
1158	8.46	Charles river, midway between mouth and lowest bridge	42 22 15	71 03 18	15	Ebb	19.5	24	2.39	43
1159	8.48	Charles river, midway between mouth and lowest bridge	42 22 15	71 03 18	30	Ebb	19.5	24	2.39	43
1160	9.00	Inner harbor off mouth of Charles river, midway to East Boston	42 22 16	71 02 55	1	Flood	19.5	18	2.84	52
1161	9.01	Inner harbor off mouth of Charles river, midway to East Boston	42 22 16	71 02 55	15	Flood	19.0	12	3.98	74
1162	9.03	Inner harbor off mouth of Charles river, midway to East Boston	42 22 16	71 02 55	30	Flood	19.0	12	3.98	74
1163	9.10	Inner harbor, midway between Charlestown and East Boston, between Charles and Mystic rivers	42 22 36	71 02 47	1	Flood	19.5	12	3.75	70

TABLE XXVII—Continued

50—BOSTON INNER HARBOR AT CHARLES RIVER. AUGUST 28, 1911—Continued.

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
1164	9.11	Inner harbor, midway between Charlestown and East Boston, between Charles and Mystic rivers	42 22 36	71 02 47	15	Flood	19.0	10	3.89	72
1165	9.13	Inner harbor, midway between Charlestown and East Boston, between Charles and Mystic rivers	42 22 36	71 02 47	30	Flood	19.0	10	3.89	72
1166	9.20	Inner harbor, off mouth of Chelsea river	42 23 09	71 02 28	1	Flood	19.5	10	3.77	70
1167	9.21	Inner harbor, off mouth of Chelsea river	42 23 09	71 02 28	15	Flood	19.0	8	4.06	75
1168	9.23	Inner harbor, off mouth of Chelsea river	42 23 09	71 02 28	25	Flood	19.0	8	4.06	75
1169	9.30	Inner harbor, just below Mystic river bridge	42 23 05	71 02 45	1	Flood	19.5	10	3.83	71
1170	9.31	Inner harbor, just below Mystic river bridge	42 23 05	71 02 45	15	Flood	19.0	8	4.00	74
1171	9.33	Inner harbor, just below Mystic river bridge	42 23 05	71 02 45	20	Flood	19.0	8	4.00	74
1172	9.40	Inner harbor, just off south branch of Mystic river	42 22 46	71 02 53	1	Flood	19.5	16	3.88	72
1173	9.41	Inner harbor, just off south branch of Mystic river	42 22 46	71 02 53	15	Flood	19.0	8	4.18	77
1174	9.43	Inner harbor, just off south branch of Mystic river	42 22 46	71 02 53	30	Flood	19.0	8	4.18	77
1175	12.00	Charles river, midway between mouth and lowest bridge	42 22 15	71 03 18	1	Flood	19.5	32	2.03	36
1176	P. M. 12.01	Charles river, midway between mouth and lowest bridge	42 22 15	71 03 18	15	Flood	19.5	18	3.48	63
1177	12.03	Charles river, midway between mouth and lowest bridge	42 22 15	71 03 18	30	Flood	19.5	18	3.48	63

51—BOSTON OUTER HARBOR IN THE VICINITY OF DEER ISLAND LIGHT. AUGUST 28, 1911

High water at Boston at 2.28 P. M.

1178	P. M. 1.00	Boston outer harbor, midway between Deer Island light and Governor's Island	42 20 36	70 58 45	1	Flood	19.0	6	5.40	100
1179	1.01	Boston outer harbor, midway between Deer Island light and Governor's Island	42 20 36	70 58 45	10	Flood	19.0	6	5.40	100
1180	1.03	Boston outer harbor, midway between Deer Island light and Governor's Island	42 20 36	70 58 45	20	Flood	19.0	6	5.40	100
1181	2.50	50 feet south of Deer Island light	42 20 23	70 57 17	1	Ebb	19.5	16	5.07	92
1182	2.51	50 feet south of Deer Island light	42 20 23	70 57 17	12	Ebb	19.0	8	5.37	99
1183	3.00	100 feet south of Deer Island light	42 20 22	70 57 17	1	Ebb	19.5	16	5.07	92
1184	3.01	100 feet south of Deer Island light	42 20 22	70 57 17	30	Ebb	19.0	8	5.36	99
1185	3.03	100 feet south of Deer Island light	42 20 22	70 57 17	60	Ebb	19.0	8	5.36	99
1186	3.12	500 feet southeast of Deer Island light	42 20 22	70 57 12	1	Ebb	19.5	10	5.00	93
1187	3.13	500 feet southeast of Deer Island light	42 20 22	70 57 12	30	Ebb	19.0	6	5.42	100
1188	3.15	500 feet southeast of Deer Island light	42 20 22	70 57 12	60	Ebb	19.0	6	5.42	100
1189	3.20	1000 feet east of Deer Island light	42 20 26	70 57 06	1	Ebb	19.0	6	5.40	100
1190	3.21	1000 feet east of Deer Island light	42 20 26	70 57 06	25	Ebb	19.0	6	5.40	100
1191	3.23	1000 feet east of Deer Island light	42 20 26	70 57 06	50	Ebb	19.0	6	5.40	100
1192	3.30	Near buoy 8, inside South channel	42 20 34	70 56 04	1	Ebb	19.0	6	5.47	100
1193	3.31	Near buoy 8, inside South channel	42 20 34	70 56 04	25	Ebb	19.0	6	5.47	100
1194	3.33	Near buoy 8, inside South channel	42 20 34	70 56 04	50	Ebb	19.0	6	5.47	100

TABLE XXVII—Continued

52—BOSTON INNER HARBOR AND CHARLES RIVER, AUGUST 29, 1911.

High water at Boston at 3.17 P. M.

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
1195	9.00	Charles river, midway between mouth and lowest bridge	42 22 15	71 03 18	1	Flood	20.0	26	2.27	41
1196	9.01	Charles river, midway between mouth and lowest bridge	42 22 15	71 03 18	15	Flood	19.5	16	3.41	62
1197	9.03	Charles river, midway between mouth and lowest bridge	42 22 15	71 03 18	30	Flood	19.5	16	3.41	62
1198	9.20	Inner harbor, midway between East Boston docks and entrance to South bay	42 21 39	71 02 35	1	Flood	19.5	10	3.69	68
1199	9.21	Inner harbor, midway between East Boston docks and entrance to South bay	42 21 39	71 02 35	15	Flood	19.0	6	4.26	80
1200	9.23	Inner harbor, midway between East Boston docks and entrance to South bay	42 21 39	71 02 35	30	Flood	19.0	6	4.26	80
1201	9.33	Inner harbor, by buoy 10, between East Boston docks and Governor's Island	42 21 35	71 01 10	1	Flood	19.5	10	4.48	83
1202	9.34	Inner harbor, by buoy 10, between East Boston docks and Governor's Island	42 21 35	71 01 10	10	Flood	19.0	6	4.83	90
1203	9.36	Inner harbor, by buoy 10 between East Boston docks and Governor's Island	42 21 35	71 01 10	15	Flood	19.0	6	4.83	90
1204	9.51	Inner harbor, midway between Governor's Island and Castle Island	42 20 42	71 00 42	1	Flood	19.5	10	4.64	86
1205	9.52	Inner harbor, midway between Governor's Island and Castle Island	42 20 42	71 00 42	15	Flood	19.0	6	5.11	95
1206	9.54	Inner harbor, midway between Governor's Island and Castle Island	42 20 42	71 00 42	30	Flood	19.0	6	5.11	95

53—BOSTON OUTER HARBOR IN THE VICINITY OF DEER ISLAND LIGHT. AUGUST 29, 1911

	A. M.									
1207	10.05	Outer harbor, midway between Governor's Island and Deer Island light.	42 20 36	70 58 45	1	Flood	19.5	8	5.40	100
1208	10.06	Outer harbor, midway between Governor's Island and Deer Island light.	42 20 36	70 58 45	10	Flood	19.0	6	5.40	100
1209	10.08	Outer harbor, midway between Governor's Island and Deer Island light.	42 20 36	70 58 45	20	Flood	19.0	6	5.40	100
1210	10.18	1000 feet west of Deer Island light	42 20 22	70 57 30	1	Flood	19.5	12	5.07	94
1211	10.19	1000 feet west of Deer Island light	42 20 22	70 57 30	20	Flood	19.0	6	5.52	100
1212	10.21	1000 feet west of Deer Island light	42 20 22	70 57 30	45	Flood	19.0	6	5.52	100
1213	10.40	10 feet west of sewer outlet at Deer Island light	42 20 23	70 57 18	1	Flood	19.5	32	2.99	53
1214	10.42	10 feet west of sewer outlet at Deer Island light	42 20 23	70 57 18	7	Flood	19.0	11	4.78	88

54—BOSTON INNER HARBOR AND CHARLES RIVER. AUGUST 29, 1911

High water at Boston at 3.17 P. M.

	P. M.									
1215	1.20	Charles river, midway between mouth and lowest bridge	42 22 15	71 03 18	1	Flood	19.5	52	2.27	38
1216	1. 1	Charles river, midway between mouth and lowest bridge	42 22 15	71 03 18	15	Flood	19.0	12	3.41	62
1217	1.23	Charles river, midway between mouth and lowest bridge	42 22 15	71 03 18	30	Flood	19.0	10	3.41	62
1218	1.32	Midway between East Boston docks and entrance to South bay	42 21 39	71 02 35	1	Flood	19.5	10	4.38	81

TABLE XXVII—Continued

54—BOSTON INNER HARBOR AND CHARLES RIVER. AUGUST 29, 1911—Continued

Sample No.	Hour P. M.	Location of Samples Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen C. C. per litre	Oxygen Per cent. saturation
			° ′ ″	° ′ ″						
1219	1.33	Midway between East Boston docks and entrance to South bay	42 21 39	71 02 35	15	Flood	19.0	6	4.79	89
1220	1.35	Midway between East Boston docks and entrance to South bay	42 21 39	71 02 35	30	Flood	19.0	6	4.79	89
1221	1.44	By buoy 10, between Governor's Island and East Boston docks	42 21 35	71 01 10	1	Flood	19.5	10	4.69	87
1222	1.45	By buoy 10, between Governor's Island and East Boston docks	42 21 35	71 01 10	10	Flood	19.0	6	5.11	95
1223	1.47	By buoy 10, between Governor's Island and East Boston docks	42 21 35	71 01 10	15	Flood	19.0	6	5.11	95
1224	1.57	Midway between Governor's Island and Castle Island	42 20 42	71 00 42	1	Flood	19.5	8	5.22	97
1225	1.58	Midway between Governor's Island and Castle Island	42 20 42	71 00 42	15	Flood	19.0	6	5.50	100
1226	2.00	Midway between Governor's Island and Castle Island	42 20 42	71 00 42	30	Flood	19.0	6	5.50	100
1227	2.20	Midway between Governor's Island and Deer Island light	42 20 36	70 58 45	1	Flood	19.0	6	5.40	100
1228	2.21	Midway between Governor's Island and Deer Island light	42 20 36	70 58 45	10	Flood	19.0	6	5.40	100
1229	2.23	Midway between Governor's Island and Deer Island light	42 20 36	70 58 45	20	Flood	19.0	6	5.40	100

55—BOSTON OUTER HARBOR, IN THE VICINITY OF DEER ISLAND LIGHT. AUGUST 29, 1911

High water at Boston at 3.17 P. M.

	P. M.									
1230	2.30	500 feet east of Deer Island light	42 20 26	70 57 12	1	Flood	19.0	11	4.93	91
1231	2.31	500 feet east of Deer Island light	42 20 26	70 57 12	15	Flood	19.0	8	5.50	100
1232	2.33	500 feet east of Deer Island light	42 20 26	70 57 12	30	Flood	19.0	7	5.50	100
1233	3.45	250 feet east of Deer Island light	40 26 26	70 57 14	Surface	Ebb	19.5	12	4.93	91
1234	3.46	250 feet east of Deer Island light	40 26 26	70 57 14	1	Ebb	19.5	12	4.93	91
1235	3.48	250 feet east of Deer Island light	40 26 26	70 57 14	2	Ebb	19.0	10	5.11	95
1236	3.50	250 feet east of Deer Island light	40 26 26	70 57 14	3	Ebb	19.0	8	5.40	100
1237	3.52	250 feet east of Deer Island light	40 26 26	70 57 14	5	Ebb	19.0	6	5.47	100
1238	3.54	250 feet east of Deer Island light	40 26 26	70 57 14	10	Ebb	19.0	6	5.47	100
1239	3.56	250 feet east of Deer Island light	40 26 26	70 57 14	15	Ebb	19.0	6	5.52	100
1240	3.58	250 feet east of Deer Island light	40 26 26	70 57 14	30	Ebb	19.0	6	5.52	100

56—BOSTON OUTER HARBOR, IN THE VICINITY OF DEER ISLAND LIGHT. AUGUST 30, 1911

High water at Boston at 4.05 P. M.

	A. M.									
1241	11.00	100 feet southwest of Deer Island light	42 20 23	70 57 18	Surface	Flood	19.5	12	4.83	90
1242	11.01	100 feet southwest of Deer Island light	42 20 23	70 57 18	1	Flood	19.5	12	4.83	90
1243	11.03	100 feet southwest of Deer Island light	42 20 23	70 57 18	2	Flood	19.0	8	5.28	98
1244	11.05	100 feet southwest of Deer Island light	42 20 23	70 57 18	3	Flood	19.0	6	5.42	100
1245	11.07	100 feet southwest of Deer Island light	42 20 23	70 57 18	5	Flood	19.0	6	5.47	100
1246	11.09	100 feet southwest of Deer Island light	42 20 23	70 57 18	10	Flood	19.0	6	5.47	100
1247	11.11	100 feet southwest of Deer Island light	42 20 23	70 57 18	30	Flood	19.0	6	5.52	100
1248	11.13	100 feet southwest of Deer Island light	42 20 23	70 57 18	60	Flood	19.0	6	5.52	100

TABLE XXVII—Continued

56—BOSTON OUTER HARBOR, IN THE VICINITY OF DEER ISLAND LIGHT. AUGUST 30, 1911—Continued

Sample No.	Hour P. M.	Location of Samples: Approximate	Location of Samples: Latitude	Location of Samples: Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen: C. C. per litre	Oxygen: Per cent. saturation
			° ′ ″	° ′ ″						
1249	3.46	100 feet south of Deer Island light....	42 20 22	70 57 17	Surface	Flood	19.5	20	4.37	80
1250	3.48	100 feet south of Deer Island light....	42 20 22	70 57 17	1	Flood	19.5	20	4.37	80
1251	3.50	100 feet south of Deer Island light....	42 20 22	70 57 17	2	Flood	19.0	12	5.14	95
1252	3.52	100 feet south of Deer Island light....	42 20 22	70 57 17	3	Flood	19.0	6	5.42	100
1253	3.54	100 feet south of Deer Island light....	42 20 22	70 57 17	5	Flood	19.0	6	5.40	100
1254	3.56	100 feet south of Deer Island light....	42 20 22	70 57 17	10	Flood	19.0	6	5.40	100
1255	3.58	100 feet south of Deer Island light....	42 20 22	70 57 17	30	Flood	19.0	6	5.52	100
1256	4.00	100 feet south of Deer Island light....	42 20 22	70 57 17	60	Flood	19.0	6	5.52	100

57—BOSTON OUTER HARBOR, OFF PEDDOCK'S ISLAND. SEPTEMBER 5, 1911

High water at Boston 9.05 A. M.

	P. M.									
1257	1.30	About ¼ mile north of west extremity of Paddock's Island...............	42 17 39	70 57 04	Surface	Ebb	19.0	16	4.93	86
1258	1.32	About ¼ mile north of west extremity of Paddock's Island...............	42 17 39	70 57 04	1	Ebb	19.0	16	4.93	86
1259	1.34	About ¼ mile north of west extremity of Paddock's Island...............	42 17 39	70 57 04	2	Ebb	19.0	14	5.11	90
1260	1.36	About ¼ mile north of west extremity of Paddock's Island...............	42 17 39	70 57 04	3	Ebb	19.0	10	5.37	96
1261	1.38	About ¼ mile north of west extremity of Paddock's Island...............	42 17 39	70 57 04	5	Ebb	19.0	8	5.37	89
1262	1.40	About ¼ mile north of west extremity of Paddock's Island...............	42 17 39	70 57 04	10	Ebb	19.0	6	5.47	99
1263	1.42	About ¼ mile north of west extremity of Paddock's Island...............	42 17 39	70 57 04	15	Ebb	19.0	6	5.56	100
1264	1.44	About ¼ mile north of west extremity of Paddock's Island...............	42 17 39	70 57 04	30	Ebb	19.0	6	5.56	100
1265	2.50	Just south of Sunken Ledge Beacon, off Paddock's Island...............	42 17 32	70 57 37	Surface	Ebb	19.0	8	5.52	100
1266	2.52	Just south of Sunken Ledge Beacon, off Paddock's Island...............	42 17 32	70 57 37	1	Ebb	19.0	8	5.50	100
1267	2.54	Just south of Sunken Ledge Beacon, off Paddock's Island...............	42 17 32	70 57 37	2	Ebb	19.0	8	5.54	100
1268	2.56	Just south of Sunken Ledge Beacon, off Paddock's Island...............	42 17 32	70 57 37	3	Ebb	19.0	8	5.54	100
1269	2.58	Just south of Sunken Ledge Beacon, off Paddock's Island...............	42 17 32	70 57 37	5	Ebb	19.0	8	5.54	100
1270	3.00	Just south of Sunken Ledge Beacon, off Paddock's Island...............	42 17 32	70 57 37	10	Ebb	19.0	8	5.56	100
1271	3.02	Just south of Sunken Ledge Beacon, off Paddock's Island...............	42 17 32	70 57 37	15	Ebb	19.0	8	5.56	100

58—BOSTON OUTER HARBOR, OFF MOON HEAD. SEPTEMBER 6, 1911

High water at Boston 9.50 A. M.

	A. M.									
1272	11.00	1000 feet north of Moon Head sewer outlet..........................	42 18 38	70 59 30	Surface	Ebb	18.5	18	4.26	73
1273	11.02	1000 feet north of Moon Head sewer outlet..........................	42 18 38	70 59 30	1	Ebb	18.5	18	4.35	75
1274	11.04	1000 feet north of Moon Head sewer outlet..........................	42 18 38	70 59 30	2	Ebb	18.5	14	5.11	90
1275	11.06	1000 feet north of Moon Head sewer outlet..........................	42 18 38	70 59 30	3	Ebb	18.5	12	5.33	95

TABLE XXVII—Continued

58—BOSTON OUTER HARBOR, OFF MOON HEAD. SEPTEMBER 6, 1911—Continued

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
1276	11.08	1000 feet north of Moon Head sewer outlet	42 18 38	70 59 30	5	Ebb	18.5	10	5.47	98
1277	11.10	1000 feet north of Moon Head sewer outlet	42 18 38	70 59 30	10	Ebb	18.5	8	5.54	99
1278	11.12	1000 feet north of Moon Head sewer outlet	42 18 38	70 59 30	15	Ebb	18.5	6	5.65	100
1279	P. M. 12.10	Near red buoy S6, north of Spectacle Island. Buoy about ¾ mile north of Moon Head outlet	42 19 06	70 59 15	Surface	Ebb	18.5	8	5.60	100
1280	12.12	Near red buoy S6, north of Spectacle Island. Buoy about ¾ mile north of Moon Head outlet	42 19 06	70 59 15	1	Ebb	18.5	8	5.62	100
1281	12.14	Near red buoy S6, north of Spectacle Island. Buoy about ¾ mile north of Moon Head outlet	42 19 06	70 59 15	2	Ebb	18.5	6	5.65	100
1282	12.16	Near red buoy S6, north of Spectacle Island. Buoy about ¾ mile north of Moon Head Outlet	42 19 06	70 59 15	3	Ebb	18.5	6	5.65	100
1283	12.18	Near red buoy S6, north of Spectacle Island. Buoy about ¾ mile north of Moon Head outlet	42 19 06	70 59 15	5	Ebb	18.5	6	5.68	100
1284	12.20	Near red buoy S6, north of Spectacle Island. Buoy about ¾ mile north of Moon Head outlet	42 19 06	70 59 15	10	Ebb	18.5	6	5.68	100
1285	12.22	Near red buoy S6, north of Spectacle Island. Buoy about ¾ mile north of Moon Head outlet	42 19 06	70 59 15	20	Ebb	18.5	6	5.68	100

59—BOSTON OUTER HARBOR, OFF PEDDOCK'S ISLAND. SEPTEMBER 7, 1911

High water at Boston at 10.28 A. M.

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
1286	A. M. 10.36	About ¼ mile north of western extremity of Paddock's Island	42 17 39	70 57 04	Surface	Ebb	17.0	16	4.83	83
1287	10.38	About ¼ mile north of western extremity of Paddock's Island	42 17 39	70 57 04	1	Ebb	17.0	16	4.93	85
1288	10.40	About ¼ mile north of western extremity of Paddock's Island	42 17 39	70 57 04	2	Ebb	17.0	14	5.07	88
1289	10.42	About ¼ mile north of western extremity of Paddocks Island	42 17 39	70 57 04	3	Ebb	17.0	8	5.56	98
1290	10.44	About ¼ mile north of western extremity of Paddock's Island	42 17 39	70 57 04	5	Ebb	17.0	8	5.56	98
1291	10.46	About ¼ mile north of western extremity of Paddock's Island	42 17 39	70 57 04	10	Ebb	17.0	6	5.65	100
1292	10.48	About ¼ mile north of western extremity of Paddock's Island	42 17 39	70 57 04	15	Ebb	17.0	4	5.68	100
1293	10.50	About ¼ mile north of western extremity of Paddock's Island	42 17 39	70 57 04	35	Ebb	17.0	4	5.68	100

60—BOSTON OUTER HARBOR, OFF MOON HEAD. SEPTEMBER 7, 1911

High water at Boston at 10.28 A. M.

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
1294	A. M. 11.20	500 feet north of sewer outlet at northwest corner of Moon Head	42 18 33	70 59 29	1	Ebb	17.0	8	5.68	100
1295	11.22	500 feet north of sewer outlet at northwest corner of Moon Head	42 18 33	70 59 29	20	Ebb	17.0	4	5.68	100
1296	P. M. 12.18	500 feet north of sewer outlet at northwest corner of Moon Head	42 18 33	70 59 29	Surface	Ebb	17.0	20	3.98	68

TABLE XXVII—Continued

60—BOSTON OUTER HARBOR, OFF MOON HEAD. SEPTEMBER 7, 1911—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
1297	12.20	500 feet north of sewer outlet at northwest corner of Moon Head..........	42 18 33	70 59 29	1	Ebb	17.0	20	3.98	68
1298	12.22	500 feet north of sewer outlet at northwest corner of Moon Head..........	42 18 33	70 59 29	2	Ebb	17.0	14	4.49	78
1299	12.24	500 feet north of sewer outlet at northwest corner of Moon Head..........	42 18 33	70 59 29	3	Ebb	17.0	12	5.00	88
1300	12.26	500 feet north of sewer outlet at northwest corner of Moon Head..........	42 18 33	70 59 29	5	Ebb	17.0	12	5.37	94
1301	12.28	500 feet north of sewer outlet at northwest corner of Moon Head..........	42 18 33	70 59 29	10	Ebb	17.0	10	5.52	97
1302	12.30	500 feet north of sewer outlet at northwest corner of Moon Head..........	42 18 33	70 59 29	20	Ebb	17.0	8	5.68	100

61—CHARLES RIVER AT BOSTON. SEPTEMBER 8, 1911

High water at Boston at 11.05 A. M.

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
1303	A. M. 10.00	Charles river, midway between mouth and lowest drawbridge............	42 22 15	71 03 18	Surface	Flood	17.0	28	2.56	43
1304	10.02	Charles river, midway between mouth and lowest drawbridge............	42 22 15	71 03 18	20	Flood	17.0	16	3.69	64

62—BOSTON OUTER HARBOR, OFF PEDDOCKS ISLAND. SEPTEMBER 9, 1911

High water at Boston at 11.45 A. M.

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
1305	A. M. 10.20	About ¼ mile north of west extremity of Peddocks Island...............	42 17 39	70 57 04	Surface	Flood	17.0	8	5.67	100
1306	10.22	About ¼ mile north of west extremity of Peddocks Island...............	42 17 39	70 57 04	1	Flood	17.0	8	5.67	100
1307	10.24	About ¼ mile north of west extermity of Peddocks Island...............	42 17 39	70 57 04	2	Flood	17.0	8	5.67	100
1308	10.26	About ¼ mile north of west extremity of Peddocks Island...............	42 17 39	70 57 04	3	Flood	17.0	6	5.68	100
1309	10.28	About ¼ mile north of west extremity of Peddocks Island...............	42 17 39	70 57 04	5	Flood	17.0	6	5.68	100
1310	10.30	About ¼ mile north of west extremity of Peddocks Island...............	42 17 39	70 57 04	10	Flood	17.0	6	5.68	100
1311	10.32	About ¼ mile north of west extremity of Peddocks Island	42 17 39	70 57 04	15	Flood	17.0	6	5.70	100
1312	10.34	About ¼ mile north of west extremity of Peddocks Island...............	42 17 39	70 57 04	35	Flood	17.0	6	5.70	100

63—BOSTON OUTER HARBOR, OFF PEDDOCKS ISLAND. SEPTEMBER 11 1911

High water at Boston at 1.06 P. M.

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
1313	A. M. 10.00	About ¼ mile north of west end of Peddocks Island..................	42 17 39	70 57 14	Surface	Flood	17.0	14	4.83	83
1314	10.02	About ¼ mile north of west end of Peddocks Island..................	42 17 39	70 57 14	1	Flood	17.0	14	4.83	83
1315	10.04	About ¼ mile north of west end of of Peddocks Island...............	42 17 39	70 57 14	2	Flood	17.0	14	4.93	85
1316	10.06	About ¼ mile north of west end of Peddocks Island..................	42 17 39	70 57 14	3	Flood	17.0	12	5.22	92

TABLE XXVII—Continued

63—BOSTON OUTER HARBOR, OFF PEDDOCKS ISLAND. SEPTEMBER 11, 1911—Continued

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
1317	10.08	About ¼ mile north of west end of Peddocks Island	42 17 39	70 57 14	5	Flood	17.0	12	5.37	94
1318	10.10	About ¼ mile north of west end of Peddocks Island	42 17 39	70 57 14	10	Flood	17.0	10	5.40	95
1319	10.12	About ¼ mile north of west end of Peddocks Island	42 17 39	70 57 14	15	Flood	17.0	10	5.56	98
1320	10.14	About ¼ mile north of west end of Peddocks Island	42 17 39	70 57 14	35	Flood	17.0	8	4.70	100

64—BOSTON OUTER HARBOR, OFF MOON HEAD. SEPTEMBER 11, 1911

High water at Boston at 1.06 P. M.

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
	P. M.									
1321	3.00	1000 feet north of Moon Head outlet	42 18 38	70 59 30	Surface	Ebb	17.0	22	3.98	68
1322	3.02	1000 feet north of Moon Head outlet	42 18 38	70 59 30	1	Ebb	17.0	22	3.98	68
1323	3.04	1000 feet north of Moon Head outlet	42 18 38	70 59 30	2	Ebb	17.0	18	4.45	76
1324	3.06	1000 feet north of Moon Head outlet	42 18 38	70 59 30	3	Ebb	17.0	14	5.07	87
1325	3.08	1000 feet north of Moon Head outlet	42 18 38	70 59 30	5	Ebb	17.0	12	5.22	92
1326	3.10	1000 feet north of Moon Head outlet	42 18 38	70 59 30	10	Ebb	17.0	8	5.52	97
1327	3.12	1000 feet north of Moon Head outlet	42 18 38	70 59 30	15	Ebb	17.0	6	5.68	100
1328	3.30	By red buoy S2, south of Long Island, west end	42 18 30	70 58 27	Surface	Ebb	17.0	20	4.26	72
1329	3.32	By red buoy S2, south of Long Island, west end	42 18 30	70 58 27	1	Ebb	17.0	20	4.26	72
1330	3.34	By red buoy S2, south of Long Island, west end	42 18 30	70 58 27	2	Ebb	17.0	16	4.92	85
1331	3.36	By red buoy S2, south of Long Island, west end	42 18 30	70 58 27	3	Ebb	17.0	12	5.22	92
1332	3.38	By red buoy S2, south of Long Island, west end	42 18 30	70 58 27	5	Ebb	17.0	10	5.51	97
1333	3.40	By red buoy S2, south of Long Island, west end	42 18 30	70 58 27	10	Ebb	17.0	6	5.68	100
1334	3.42	By red buoy S2, south of Long Island, west end	42 18 30	70 58 27	20	Ebb	17.0	6	5.70	100
1335	4.00	1000 feet east of red buoy S. 2, south of Long Island	42 18 32	70 58 14	Surface	Ebb	17.0	8	5.54	97
1336	4.02	1000 feet east of red buoy S. 2, south of Long Island	42 18 32	70 58 14	1	Ebb	17.0	8	5.54	97
1337	4.04	1000 feet east of red buoy S. 2, south of Long Island	42 18 32	70 58 14	2	Ebb	17.0	8	5.54	97
1338	4.06	1000 feet east of red buoy S. 2, south of Long Island	42 18 32	70 58 14	3	Ebb	17.0	6	5.60	98
1339	4.08	1000 feet east of red buoy S. 2, south of Long Island	42 18 32	70 58 14	5	Ebb	17.0	6	5.56	97
1340	4.10	1000 feet east of red buoy S. 2, south of Long Island	42 18 32	70 58 14	10	Ebb	17.0	6	5.46	96
1341	4.12	1000 feet east of red buoy S. 2, south of Long Island	42 18 32	70 58 14	25	Ebb	17.0	6	5.46	96

65—BOSTON OUTER HARBOR, OFF PEDDOCKS ISLAND. SEPTEMBER 12, 1911

High water occurred at Boston at 1.50 P. M.

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
	A. M.									
1342	9.40	About ¼ mile north of west end of Peddocks Island, over outlet, which discharges 30 feet below surface	42 17 39	70 57 04	Surface	Flood	17.0	12	5.19	89
1343	9.42	About ¼ mile north of west end of Peddocks Island, over outlet, which discharges 30 feet below surface	42 17 39	70 57 04	1	Flood	17.0	12	5.18	89

TABLE XXVII—Continued

65—BOSTON OUTER HARBOR, OFF PEDDOCKS ISLAND. SEPTEMBER 12, 1911—Continued

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
1344	9.44	About ¼ mile north of west end of Peddocks Island, over outlet, which discharges 30 feet below surface.....	42 17 39	70 57 04	2	Flood	17.0	12	5.22	90
1345	9.46	About ¼ mile north of west end of Peddocks Island, over outlet, which discharges 30 feet below surface.....	42 17 39	70 57 04	3	Flood	17.0	10	5.37	94
1346	9.48	About ¼ mile north of west end of Peddocks Island, over outlet, which discharges 30 feet below surface.....	42 17 39	70 57 04	5	Flood	17.0	10	5.40	95
1347	9.50	About ¼ mile north of west end of Peddocks Island, over outlet, which discharges 30 feet below surface.....	42 17 39	70 57 04	10	Flood	17.0	8	5.52	97
1348	9.52	About ¼ mile north of west end of Peddocks Island, over outlet, which discharges 30 feet below surface.....	42 17 39	70 57 04	15	Flood	17.0	8	5.56	98
1349	9.54	About ¼ mile north of west end of Peddocks Island, over outlet, which discharges 30 feet below surface.....	42 17 39	70 57 04	35	Flood	17.0	6	5.74	100
1350	10.50	Near Sunken Ledge beacon, ½ mile west of Peddocks Island outlet.....	42 17 32	70 57 37	Surface	Flood	17.0	8	5.68	100
1351	10.52	Near Sunken Ledge beacon, ½ mile west of Peddocks Island outlet.....	42 17 32	70 57 37	1	Flood	17.0	8	5.68	100
1352	10.54	Near Sunken Ledge beacon, ½ mile west of Peddocks Island outlet.....	42 17 32	70 57 37	2	Flood	17.0	8	5.68	100
1353	10.56	Near Sunken Ledge beacon, ½ mile west of Peddocks Island outlet.....	42 17 32	70 57 37	3	Flood	17.0	6	5.70	100
1354	10.58	Near Sunken Ledge beacon, ½ mile west of Peddocks Island outlet.....	42 17 32	70 57 37	5	Flood	17.0	6	5.73	100
1355	11.00	Near Sunken Ledge beacon, ½ mile west of Peddocks Island outlet.....	42 17 32	70 57 37	10	Flood	17.0	6	5.74	100
1356	11.02	Near Sunken Ledge beacon, ½ mile west of Peddocks Island outlet.....	42 17 32	70 57 37	15	Flood	17.0	6	5.74	100
1357	11.50	½ mile east of Peddocks Island outlet	42 17 44	70 56 30	Surface	Flood	17.0	8	5.68	100
1358	11.52	½ mile east of Peddocks Island outlet	42 17 44	70 56 30	1	Flood	17.0	8	5.68	100
1359	11.54	½ mile east of Peddocks Island outlet	42 17 44	70 56 30	2	Flood	17.0	8	5.68	100
1360	11.56	½ mile east of Peddocks Island outlet	42 17 44	70 56 30	3	Flood	17.0	6	5.70	100
1361	11.58	½ mile east of Peddocks Island outlet	42 17 44	70 56 30	5	Flood	17.0	6	5.74	100
1362	12.00	½ mile east of Peddocks Island outlet	42 17 44	70 56 30	10	Flood	17.0	6	5.74	100
	P. M.									
1363	12.02	½ mile east of Peddocks Island outlet	42 17 44	70 56 30	15	Flood	17.0	6	5.74	100
1364	2.00	About ¼ mile north of west end of Peddocks Island, over outlet, discharging 30 feet below surface......	42 17 39	70 57 04	Surface	Ebb	17.0	14	4.92	85
1365	2.02	About ¼ mile north of west end of Peddocks Island, over outlet, discharging 30 feet below surface......	42 17 39	70 57 04	1	Ebb	17.0	14	4.92	85
1366	2.04	About ¼ mile north of west end of Peddocks Island, over outlet, discharging 30 feet below surface......	42 17 39	70 57 04	2	Ebb	17.0	14	4.93	86
1367	2.06	About ¼ mile north of west end of Peddocks Island, over outlet, discharging 30 feet below surface......	42 17 39	70 57 04	3	Ebb	17.0	12	5.07	89
1368	2.08	About ¼ mile north of west end of Peddocks Island, over outlet, discharging 30 feet below surface......	42 17 39	70 57 04	5	Ebb	17.0	12	5.22	92
1369	2.10	About ¼ mile north of west end of Peddocks Island, over outlet, discharging 30 feet below surface......	42 17 39	70 57 04	10	Ebb	17.0	10	5.28	93

TABLE XXVII—Continued

65—BOSTON OUTER HARBOR, OFF PEDDOCKS ISLAND. SEPTEMBER 12, 1911—Continued

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
1370	2.12	About ¼ mile north of west end of Peddocks Island, over outlet, discharging 30 feet below surface......	42 17 39	70 57 04	15	Ebb	17.0	8	5.42	95
1371	2.14	About ¼ mile north of west end of Peddocks Island, over outlet, discharging 30 feet below surface......	42 17 39	70 57 04	35	Ebb	17.0	6	5.65	99

66—CHARLES RIVER, BOSTON. SEPTEMBER 13, 1911

High water at Boston at 2.37 P. M.

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
1372	A. M. 9.30	Charles river, midway between mouth and lowest bridge................	42 22 15	71 03 18	1	Flood	16.0	26	3.77	64
1373	9.34	Charles river, midway between mouth and lowest bridge................	42 22 15	71 03 18	20	Flood	16.5	12	3.77	66

67—BOSTON OUTER HARBOR, OFF PEDDOCKS ISLAND. SEPTEMBER 14, 1911

High water at Boston at 3.29 P. M.

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
1374	A. M. 10.15	About ¼ mile north of west end of Peddocks Island..................	42 17 39	70 57 04	Surface	Flood	15.5	14	5.19	88
1375	10.16	About ¼ mile north of west end of Peddocks Island..................	42 17 39	70 57 04	1	Flood	15.5	14	5.19	88
1376	10.18	About ¼ mile north of west end of Peddocks Island..................	42 17 39	70 57 04	2	Flood	15.5	14	5.22	89
1377	10.20	About ¼ mile north of west end of Peddocks Island..................	42 17 39	70 57 04	3	Flood	15.5	12	5.37	93
1378	10.22	About ¼ mile north of west end of Peddocks Island..................	42 17 39	70 57 04	5	Flood	15.5	12	5.40	93
1379	10.24	About ¼ mile north of west end of Peddocks Island..................	42 17 39	70 57 04	10	Flood	15.5	10	5.52	96
1380	10.26	About ¼ mile north of west end of Peddocks Island..................	42 17 30	70 57 04	15	Flood	15.5	10	5.56	97
1381	10.28	About ¼ mile north of west end of Peddocks Island..................	42 17 39	70 57 04	35	Flood	15.5	8	5.74	98
1382	11.00	½ way between outlet and west end of Peddocks Island..................	42 17 32	70 57 02	Surface	Flood	15.5	12	5.46	94
1383	11.02	½ way between outlet and west end of Peddocks Island..................	42 17 32	70 57 02	1	Flood	15.5	12	5.46	94
1384	11.04	½ way between outlet and west end of Peddocks Island..................	42 17 32	70 57 02	2	Flood	15.5	12	5.46	94
1385	11.06	½ way between outlet and west end of Peddocks Island..................	42 17 32	70 57 02	3	Flood	15.5	10	5.56	96
1386	11.08	½ way between outlet and west end of Peddocks Island..................	42 17 32	70 57 02	5	Flood	15.5	10	5.56	96
1387	11.10	½ way between outlet and west end of Peddocks Island..................	42 17 32	70 57 02	10	Flood	15.5	8	5.68	98
1388	11.12	½ way between outlet and west end of Peddocks Island..................	42 17 32	70 57 02	15	Flood	15.5	6	5.80	100
1389	11.14	½ way between outlet and west end of Peddocks Island..................	42 17 32	70 57 02	35	Flood	15.5	6	5.80	100
1390	11.50	About ¼ mile west of west end of Peddocks Island......................	42 17 23	70 57 18	Surface	Flood	15.5	8	5.60	97
1391	11.52	About ¼ mile west of west end of Peddocks Island......................	42 17 23	70 57 18	1	Flood	15.5	8	5.60	97

TABLE XXVII—Continued

67—BOSTON OUTER HARBOR, OFF PEDDOCKS ISLAND SEPTEMBER 14, 1911—Continued.

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
1392	11.54	About ¼ mile west of west end of Peddocks Island	42 17 23	70 57 18	2	Flood	15.5	8	5.60	97
1393	11.56	About ¼ mile west of west end of Peddocks Island	42 17 23	70 57 18	3	Flood	15.5	6	5.68	98
1394	11.58	About ¼ mile west of west end of Peddocks Island	42 17 23	70 57 18	5	Flood	15.5	6	5.68	98
1395	12.00	About ¼ mile west of west end of Peddocks Island	42 17 23	70 57 18	10	Flood	15.5	6	5.68	98
1396	P. M. 12.02	About ¼ mile west of west end of Peddocks Island	42 17 23	70 57 18	15	Flood	15.5	6	5.56	96
1397	12.04	About ¼ mile west of west end of Peddocks Island	42 17 23	70 57 18	25	Flood	15.5	6	5.56	96
1398	1.00	½ mile southwest of outlet	42 17 16	70 57 22	Surface	Flood	15.5	8	5.60	97
1399	1.01	½ mile southwest of outlet	42 17 16	70 57 22	1	Flood	15.5	8	5.60	97
1400	1.03	½ mile southwest of outlet	42 17 16	70 57 22	2	Flood	15.5	8	5.60	97
1401	1.05	½ mile southwest of outlet	42 17 16	70 57 22	3	Flood	15.5	6	5.68	98
1402	1.07	½ mile southwest of outlet	42 17 16	70 57 22	5	Flood	15.5	6	5.68	98
1403	1.09	½ mile southwest of outlet	42 17 16	70 57 22	10	Flood	15.5	6	5.68	98
1404	1.11	½ mile southwest of outlet	42 17 16	70 57 22	15	Flood	15.5	6	5.56	96
1405	1.13	½ mile southwest of outlet	42 17 16	70 57 22	30	Flood	15.5	6	5.52	95
1406	2.00	By black buoy S. 3, between Long Island and Rainsford Island	42 19 04	70 56 55	1	Flood	15.5	6	5.74	100
1407	2.02	By black buoy S. 3, between Long Island and Rainsford Island	42 19 04	70 56 55	15	Flood	15.5	4	5.74	100
1408	2.04	By black buoy S. 3, between Long Island and Rainsford Island	42 19 04	70 56 55	30	Flood	15.5	4	5.74	100
1409	2.30	Cove north of middle of Peddocks Island, 1000 feet off shore	42 17 46	70 56 22	1	Flood	15.5	6	5.51	97
1410	2.32	Cove north of middle of Peddocks Island, 1000 feet off shore	42 17 46	70 56 22	10	Flood	15.5	4	5.51	97
1411	2.34	Cove north of middle of Peddocks Island, 1000 feet off shore	42 17 46	70 56 22	15	Flood	15.5	4	5.51	97
1412	4.00	About ¼ mile north of west end of Peddocks Island	42 17 39	70 57 04	1	Flood	15.5	14	4.93	83
1413	4.04	About ¼mile north of west end of Peddocks Island	42 17 39	70 57 04	30	Flood	15.5	6	5.80	100

68—BOSTON OUTER HARBOR, OFF MOON ISLAND. SEPTEMBER 14, 1911

High water at Boston at 3.29 P. M.

1414	P. M. 5.00	Midway between Moon Head outlet and east end of Spectacle Island	42 18 52	70 59 17	Surface	Ebb	15.5	18	3.98	68
1415	5.02	Midway between Moon Head outlet and east end of Spectacle Island	42 18 52	70 59 17	1	Ebb	15.5	18	3.98	68
1416	5.04	Midway between Moon Head outlet and east end of Spectacle Island	42 18 52	70 59 17	2	Ebb	15.5	14	4.11	73
1417	5.06	Midway between Moon Head outlet and east end of Spectacle Island	42 18 52	70 59 17	3	Ebb	15.5	12	4.90	85
1418	5.08	Midway between Moon Head outlet and east end of Spectacle Island	42 18 52	70 59 17	5	Ebb	15.5	10	5.22	92
1419	5.10	Midway between Moon Head outlet and east end of Spectacle Island	42 18 52	70 59 17	10	Ebb	15.5	6	5.52	97
1420	5.12	Midway between Moon Head outlet and east end of Spectacle Island	42 18 52	70 59 17	15	Ebb	15.5	4	5.68	100

TABLE XXVII—Continued

68—BOSTON OUTER HARBOR, OFF MOON HEAD. SEPTEMBER 14, 1911—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
1421	5.30	By buoy S. 4, off west end of Long Island	42 18 34	70 58 46	Surface	Ebb	15.5	16	4.26	72
1422	5.32	By buoy S. 4, off west end of Long Island	42 18 34	70 58 46	1	Ebb	15.5	16	4.26	72
1423	5.34	By buoy S. 4, off west end of Long Island	42 18 34	70 58 46	2	Ebb	15.5	14	4.64	80
1424	5.36	By buoy S. 4, off west end of Long Island	42 18 34	70 58 46	3	Ebb	15.5	12	5.00	86
1425	5.38	By buoy S. 4, off west end of Long Island	42 18 34	70 58 46	5	Ebb	15.5	10	5.51	97
1426	5.40	By buoy S. 4, off west end of Long Island	42 18 34	70 58 46	10	Ebb	15.5	6	5.68	100
1427	5.42	By buoy S. 4, off west end of Long Island	42 18 34	70 58 46	15	Ebb	15.5	4	5.68	100
1428	6.04	By buoy S. 2, south of west end of Long Island	42 18 30	70 58 27	Surface	Ebb	15.5	8	5.54	96
1429	6.06	By buoy S. 2, south of west end of Long Island	42 18 30	70 58 27	1	Ebb	15.5	8	5.54	96
1430	6.08	By buoy S. 2, south of west end of Long Island	42 18 30	70 58 27	2	Ebb	15.5	6	5.54	96
1431	6.10	By buoy S. 2, south of west end of Long Island	42 18 30	70 58 27	3	Ebb	15.5	6	5.60	98
1432	6.12	By buoy S. 2, south of west end of Long Island	42 18 30	70 58 27	5	Ebb	15.5	6	5.56	97
1433	6.14	By buoy S. 2, south of west end of Long Island	42 18 30	70 58 27	10	Ebb	15.5	4	5.46	96
1434	6.16	By buoy S. 2, south of west end of Long Island	42 18 30	70 58 27	20	Ebb	15.5	4	5.46	96

69—BOSTON OUTER HARBOR, OFF PEDDOCKS ISLAND. SEPTEMBER 15, 1911

High water at Boston at 4.26 P. M.

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
	A. M.									
1435	10.30	About ¼ mile north of west end of Peddocks Island, over outlet	42 17 39	70 57 04	Surface	Flood	15.5	14	5.19	88
1436	10.32	About ¼ mile north of west end of Peddocks Island, over outlet	42 17 39	70 57 04	1	Flood	15.5	14	5.19	88
1437	10.34	About ¼ mile north of west end of Peddocks Island, over outlet	42 17 39	70 57 04	2	Flood	15.5	14	5.22	89
1438	10.36	About ¼ mile north of west end of Peddocks Island, over outlet	42 17 39	70 57 04	3	Flood	15.5	12	5.37	93
1439	10.38	About ¼ mile north of west end of Peddocks Island, over outlet	42 17 39	70 57 04	5	Flood	15.5	10	5.54	96
1440	10.40	About ¼ mile north of west end of Peddocks Island, over outlet	42 17 39	70 57 04	10	Flood	15.5	10	5.52	96
1441	10.42	About ¼ mile north of west end of Peddocks Island, over outlet	42 17 39	70 57 04	15	Flood	15.5	8	5.56	97
1442	10.44	About ¼ mile north of west end of Peddocks Island, over outlet	42 17 39	70 57 04	30	Flood	15.5	6	5.74	99

TABLE XXVII—Continued

70—BOSTON OUTER HARBOR, OFF MOON HEAD. SEPTEMBER 15, 1911

High water at Boston at 4.26 P. M.

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
1443	11.30	1000 feet north of Moon Head outlet..	42 18 38	70 59 30	Surface	Flood	15.5	6	5.68	100
1444	11.32	1000 feet north of Moon Head outlet..	42 18 38	70 59 30	1	Flood	15.5	6	5.68	100
1445	11.34	1000 feet north of Moon Head outlet..	42 18 38	70 59 30	2	Flood	15.5	6	5.68	100
1446	11.36	1000 feet north of Moon Head outlet..	42 18 38	70 59 30	3	Flood	15.5	6	5.70	100
1447	11.38	1000 feet north of Moon Head outlet..	42 18 38	70 59 30	5	Flood	15.5	4	5.70	100
1448	11.40	1000 feet north of Moon Head outlet..	42 18 38	70 59 30	10	Flood	15.5	4	5.74	100
1449	11.42	1000 feet north of Moon Head outlet..	42 18 38	70 59 30	15	Flood	15.5	4	5.74	100

71—BOSTON OUTER HARBOR, OFF MOON HEAD. SEPTEMBER 18, 1911

High water occurred at Boston at 7.17 A. M.

	A. M.									
1450	9.15	About 1 mile southeast of Moon Head outlet and 1 mile south of west end of Long Island..................	42 18 02	70 58 27	Surface	Ebb	15.5	6	5.07	88
1451	9.17	About 1 mile southeast of Moon Head outlet and 1 mile south of west end of Long Island..................	42 18 02	70 58 27	1	Ebb	15.5	6	5.07	88
1452	9.19	About 1 mile southeast of Moon Head outlet and 1 mile south of west end of Long Island..................	42 18 02	70 58 27	2	Ebb	15.5	6	5.11	89
1453	9.21	About 1 mile southeast of Moon Head outlet and 1 mile south of west end of Long Island..................	42 18 02	70 58 27	3	Ebb	15.5	6	5.11	89
1454	9.23	About 1 mile southeast of Moon Head outlet and 1 mile south of west end of Long Island..................	42 18 02	70 58 27	5	Ebb	15.5	6	5.11	89
1455	9.25	About 1 mile southeast of Moon Head outlet and 1 mile south of west end of Long Island..................	42 18 02	70 58 27	10	Ebb	15.5	6	5.00	86
1456	9.27	About 1 mile southeast of Moon Head outlet and 1 mile south of west end of Long Island..................	42 18 02	70 58 27	15	Ebb	15.5	6	5.00	86
1457	9.50	About 1 mile southeast of Moon Head outlet and 1 mile south of west end of Long Island..................	42 18 02	70 58 27	Surface	Ebb	15.5	14	4.40	75
1458	9.52	About 1 mile southeast of Moon Head outlet and 1 mile south of west end of Long Island..................	42 18 02	70 58 27	1	Ebb	15.5	14	4.40	75
1459	9.54	About 1 mile southeast of Moon Head outlet and 1 mile south of west end of Long Island..................	42 18 02	70 58 27	2	Ebb	15.5	12	4.78	82
1460	9.56	About 1 mile southeast of Moon Head outlet and 1 mile south of west end of Long Island..................	42 18 02	70 58 27	3	Ebb	15.5	10	5.14	89
1461	9.58	About 1 mile southeast of Moon Head outlet and 1 mile south of west end of Long Island..................	42 18 02	70 58 27	5	Ebb	15.5	10	5.51	97
1462	10.00	About 1 mile southeast of Moon Head outlet and 1 mile south of west end of Long Island..................	42 18 02	70 58 27	10	Ebb	15.5	6	5.68	100
1463	10.02	About 1 mile southeast of Moon Head outlet and 1 mile south of west end of Long Island..................	42 18 02	70 58 27	15	Ebb	15.5	6	5.70	100
1464	10.25	1000 feet north of Moon Head outlet..	42 18 38	70 59 30	Surface	Ebb	15.5	18	3.98	68
1465	10.27	1000 feet north of Moon Head outlet..	42 18 38	70 59 30	1	Ebb	15.5	18	3.98	68

TABLE XXVII—Continued

71—BOSTON OUTER HARBOR, OFF MOON HEAD. SEPTEMBER 18, 1911—Continued

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
1466	10.29	1000 feet north of Moon Head outlet..	42 18 38	70 59 30	2	Ebb	15.5	14	4.26	74
1467	10.31	1000 feet north of Moon Head outlet..	42 18 38	70 59 30	3	Ebb	15.5	12	4.90	85
1468	10.33	1000 feet north of Moon Head outlet..	42 18 38	70 59 30	5	Ebb	15.5	10	5.22	92
1469	10.35	1000 feet north of Moon Head outlet..	42 18 38	70 59 30	10	Ebb	15.5	8	5.52	97
1470	10.37	1000 feet north of Moon Head outlet..	42 18 38	70 59 30	15	Ebb	15.5	8	5.60	98
1471	11.00	About ¼ mile south of location of samples Nos. 1457–1463, which were taken near south edge of discolored field..........................	42 17 50	70 58 23	Surface	Ebb	15.5	6	5.60	98
1472	11.02	About ¼ mile south of location of samples Nos. 1457–1463, which were taken near south edge of discolored field..........................	42 17 50	70 59 23	10	Ebb	15.5	6	5.60	98
1473	11.04	About ¼ mile south of location of samples Nos. 1457–1463, which were taken near south edge of discolored field..........................	42 17 50	70 59 23	15	Ebb	15.5	6	5.52	97

72—NARROWS, CROSS-SECTION BETWEEN FORTS LAFAYETTE AND WADSWORTH. SEPTEMBER 26, 1911

Low water occurred at Governor's Island at 4.17 A. M. High water at 10.33 A. M. Low water at 4.57 P. M. Flood currents began about 7 A. M. Flood currents ended about 12 Noon. Ebb currents began about 12.30 P.M. Ebb currents ended 7.30 P.M. (estimated.)

1474	6.30	200 feet off Fort Lafayette..........	40 36 29	74 02 24	1	Slack	20.0	30	3.69	65
1475	6.32	200 feet off Fort Lafayette..........	40 36 29	74 02 24	20	Slack	20.0	24	3.83	68
1476	6.34	200 feet off Fort Lafayette..........	40 36 29	74 02 24	40	Slack	20.0	24	3.83	68
1477	6.39	¼ way across from Fort Lafayette....	40 36 27	74 02 34	1	Slack	20.0	30	3.78	67
1478	6.41	¼ way across from Fort Lafayette....	40 36 27	74 02 34	40	Slack	20.0	24	3.92	70
1479	6.43	¼ way across from Fort Lafayette....	40 36 27	74 02 34	80	Slack	20.0	24	3.92	70
1480	6.48	Half way across....................	40 36 25	74 02 48	1	Slack	20.0	30	3.91	69
1481	6.50	Half way across....................	40 36 25	74 02 48	40	Slack	20.0	24	3.91	70
1482	6.52	Half way across....................	40 36 25	74 02 48	80	Slack	20.0	24	3.91	70
1483	6.57	¾ way across from Fort Lafayette....	40 36 23	74 03 02	1	Slack	20.0	30	3.84	68
1484	6.59	¾ way across from Fort Lafayette....	40 36 23	74 03 02	40	Slack	20.0	24	3.84	69
1485	7.01	¾ way across from Fort Lafayette....	40 36 23	74 03 02	80	Slack	20.0	24	3.84	69
1486	7.06	200 feet off Fort Wadsworth.........	40 36 21	74 03 12	1	Flood	20.0	30	3.75	66
1487	7.08	200 feet off Fort Wadsworth.........	40 36 21	74 03 12	30	Flood	20.0	24	3.89	69
1488	7.10	200 feet off Fort Wadsworth.........	40 36 21	74 03 12	60	Flood	20.0	24	3.89	69
1489	8.30	200 feet off Fort Lafayette..........	40 36 29	74 02 24	1	Flood	20.0	26	4.65	83
1490	8.32	200 feet off Fort Lafayette..........	40 36 29	74 02 24	20	Flood	20.0	20	4.94	89
1491	8.34	200 feet off Fort Lafayette..........	40 36 29	74 02 24	40	Flood	20.0	20	4.94	89
1492	8.39	¼ way across from Fort Lafayette....	40 36 27	74 02 34	1	Flood	20.0	26	4.76	85
1493	8.41	¼ way across from Fort Lafayette....	40 36 27	74 02 34	40	Flood	20.0	20	5.04	91
1494	8.43	¼ way across from Fort Lafayette....	40 36 27	74 02 34	80	Flood	20.0	20	5.04	91
1495	8.48	Half way across....................	40 36 25	74 02 48	1	Flood	20.0	26	4.78	85
1496	8.50	Half way across....................	40 36 25	74 02 48	40	Flood	20.0	20	4.92	89
1497	8.52	Half way across....................	40 36 25	74 02 48	80	Flood	20.0	20	4.92	89
1498	8.57	¾ way across from Fort Lafayette....	40 36 23	74 03 02	1	Flood	20.0	26	4.83	86
1499	8.59	¾ way across from Fort Lafayette....	40 36 23	74 03 02	40	Flood	20.0	20	5.00	90
1500	9.01	¾ way across from Fort Lafayette....	40 36 23	74 03 02	80	Flood	20.0	20	5.00	90
1501	9.06	200 feet off Fort Wadsworth.........	40 36 21	74 03 12	1	Flood	20.0	26	4.72	84
1502	9.08	200 feet off Fort Wadsworth.........	40 36 21	74 03 12	30	Flood	20.0	20	5.00	90
1503	9.10	200 feet off Fort Wadsworth.........	40 36 21	74 03 12	60	Flood	20.0	20	5.00	90

TABLE XXVII—Continued

72—THE NARROWS—CROSS-SECTION BETWEEN FORTS LAFAYETTE AND WADSWORTH. SEPTEMBER 26, 1911—Continued

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude ° ′ ″	Longitude ° ′ ″					C. C. per litre	Per cent. saturation
1504	10.30	200 feet off Fort Lafayette	40 36 29	74 02 24	1	End of Flood	20.0	26	4.78	85
1505	10.32	200 feet off Fort Lafayette	40 36 29	74 02 24	20	End of Flood	20.0	20	4.94	89
1506	10.34	200 feet off Fort Lafayette	40 36 29	74 02 24	40	End of Flood	20.0	20	4.94	89
1507	10.39	¼ way across from Fort Lafayette	40 36 27	74 02 34	1	End of Flood	20.0	26	4.90	87
1508	10.41	¼ way across from Fort Lafayette	40 36 27	74 02 34	40	End of Flood	20.0	20	5.04	91
1509	10.43	¼ way across from Fort Lafayette	40 36 27	74 02 34	80	End of Flood	20.0	20	5.04	91
1510	10.48	Half way across	40 36 25	74 02 48	1	End of Flood	20.0	26	4.92	88
1511	10.50	Half way across	40 36 25	74 02 48	40	End of Flood	20.0	20	4.92	89
1512	10.52	Half way across	40 36 25	74 02 48	80	End of Flood	20.0	20	4.92	89
1513	10.57	¾ way across from Fort Lafayette	40 36 23	74 03 02	1	End of Flood	20.0	26	5.00	89
1514	10.59	¾ way across from Fort Lafayette	40 36 23	74 03 02	40	End of Flood	20.0	20	5.00	90
1515	11.01	¾ way across from Fort Lafayette	40 36 23	74 03 02	80	End of Flood	20.0	20	5.00	90
1516	11.06	200 feet off Fort Wadsworth	40 36 21	74 03 12	1	End of Flood	20.0	26	5.00	89
1517	11.08	200 feet off Fort Wadsworth	40 36 21	74 03 12	30	End of Flood	20.0	20	5.00	90
1518	11.10	200 feet off Fort Wadsworth	40 36 21	74 03 12	60	End of Flood	20.0	20	5.00	90
1519	P. M. 12.30	200 feet off Fort Lafayette	40 36 29	74 02 24	1	Ebb	20.0	26	4.78	85
1520	12.32	200 feet off Fort Lafayette	40 36 29	74 02 24	20	Ebb	20.0	20	4.78	86
1521	12.34	200 feet off Fort Lafayette	40 36 29	74 02 24	40	Ebb	20.0	20	4.78	86
1522	12.39	¼ way across from Fort Lafayette	40 36 27	74 02 34	1	Ebb	20.0	26	4.90	87
1523	12.41	¼ way across from Fort Lafayette	40 36 27	74 02 34	40	Ebb	20.0	20	4.90	88
1524	12.43	¼ way across from Fort Lafayette	40 36 27	74 02 34	80	Ebb	20.0	20	4.90	88
1525	12.48	Half way across	40 36 25	74 02 48	1	Ebb	20.0	26	4.78	85
1526	12.50	Half way across	40 36 25	74 02 48	40	Ebb	20.0	20	4.92	89
1527	12.52	Half way across	40 36 25	74 02 48	80	Ebb	20.0	20	4.92	89
1528	12.57	¾ way across from Fort Lafayette	40 36 23	74 03 02	1	Ebb	20.0	28	4.83	85
1529	12.59	¾ way across from Fort Lafayette	40 36 23	74 03 02	40	Ebb	20.0	20	4.83	87
1530	1.01	¾ way across from Fort Lafayette	40 36 23	74 03 02	80	Ebb	20.0	20	4.83	87
1531	1.06	200 feet off Fort Wadsworth	40 36 21	74 03 12	1	Ebb	20.0	28	4.72	84
1532	1.08	200 feet off Fort Wadsworth	40 36 21	74 03 12	40	Ebb	20.0	20	4.87	88
1533	1.10	200 feet off Fort Wadsworth	40 36 21	74 03 12	80	Ebb	20.0	20	4.87	88
1534	2.30	200 feet off Fort Lafayette	40 36 29	74 02 24	1	Ebb	20.0	28	4.38	77
1535	2.32	200 feet off Fort Lafayette	40 36 29	74 02 24	20	Ebb	20.0	24	4.51	81
1536	2.34	200 feet off Fort Lafayette	40 36 29	74 02 24	40	Ebb	20.0	24	4.51	81
1537	2.39	¼ way across from Fort Lafayette	40 36 27	74 02 34	1	Ebb	20.0	28	4.48	79
1538	2.41	¼ way across from Fort Lafayette	40 36 27	74 02 34	40	Ebb	20.0	24	4.48	80
1539	2.43	¼ way across from Fort Lafayette	40 36 27	74 02 34	80	Ebb	20.0	24	4.48	80
1540	2.48	Half way across	40 36 25	74 02 48	1	Ebb	20.0	28	4.34	77
1541	2.50	Half way across	40 36 25	74 02 48	40	Ebb	20.0	24	4.34	78
1542	2.52	Half way across	40 36 25	74 02 48	80	Ebb	20.0	24	4.34	78
1543	2.57	¾ way across from Fort Lafayette	40 36 23	74 03 02	1	Ebb	20.0	28	4.26	75

TABLE XXVII—Continued

72—THE NARROWS—CROSS-SECTION BETWEEN FORTS LAFAYETTE AND WADSWORTH. SEPTEMBER 26, 1911—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
1544	2.59	¾ way across from Fort Lafayette....	40 36 23	74 03 02	40	Ebb	20.0	24	4.26	76
1545	3.01	¾ way across from Fort Lafayette....	40 36 23	74 03 02	80	Ebb	20.0	24	4.26	76
1546	3.06	200 feet off Fort Wadsworth.........	40 36 21	74 03 12	1	Ebb	20.0	26	4.31	77
1547	3.08	200 feet off Fort Wadsworth.........	40 36 21	74 03 12	30	Ebb	20.0	24	4.31	77
1548	3.10	200 feet off Fort Wadsworth.........	40 36 21	74 03 12	60	Ebb	20.0	24	4.31	77
1549	4.30	200 feet off Fort Lafayette...........	40 36 29	74 02 24	1	Ebb	20.0	30	3.96	70
1550	4.32	200 feet off Fort Lafayette...........	40 36 29	74 02 24	20	Ebb	20.0	28	3.96	70
1551	4.34	200 feet off Fort Lafayette...........	40 36 29	74 02 24	40	Ebb	20.0	28	3.96	70
1552	4.39	¼ way across from Fort Lafayette....	40 36 27	74 02 34	1	Ebb	20.0	30	4.06	72
1553	4.41	¼ way across from Fort Lafayette....	40 36 27	74 02 34	40	Ebb	20.0	28	4.06	72
1554	4.43	¼ way across from Fort Lafayette....	40 36 27	74 02 34	80	Ebb	20.0	28	4.06	72
1555	4.48	Half way across.....................	40 36 25	74 02 48	1	Ebb	20.0	28	4.06	72
1556	4.50	Half way across.....................	40 36 25	74 02 48	40	Ebb	20.0	26	4.06	72
1557	4.52	Half way across.....................	40 36 25	74 02 48	80	Ebb	20.0	26	4.06	72
1558	4.57	¾ way across from Fort Lafayette....	40 36 23	74 03 02	1	Ebb	20.0	28	3.98	70
1559	4.59	¾ way across from Fort Lafayette....	40 36 23	74 03 02	40	Ebb	20.0	26	3.98	71
1560	5.01	¾ way across from Fort Lafayette....	40 36 23	74 03 02	80	Ebb	20.0	26	3.98	71
1561	5.06	200 feet off Fort Wadsworth.........	40 36 21	74 03 12	1	Ebb	20.0	28	3.89	69
1562	5.08	200 feet off Fort Wadsworth.........	40 36 21	74 03 12	30	Ebb	20.0	26	4.03	72
1563	5.10	200 feet off Fort Wadsworth.........	40 36 21	74 03 12	60	Ebb	20.0	26	4.03	72
1564	6.00	200 feet off Fort Lafayette...........	40 36 29	74 02 24	1	Ebb	20.0	30	3.69	65
1565	6.02	200 feet off Fort Lafayette...........	40 36 29	74 02 24	20	Ebb	20.0	28	3.83	68
1566	6.04	200 feet off Fort Lafayette...........	40 36 29	74 02 24	40	Ebb	20.0	28	3.83	68
1567	6.08	¼ way across from Fort Lafayette....	40 36 27	74 02 34	1	Ebb	20.0	30	3.78	67
1568	6.10	¼ way across from Fort Lafayette....	40 36 27	74 02 34	40	Ebb	20.0	28	3.92	69
1569	6.12	¼ way across from Fort Lafayette....	40 36 27	74 02 34	80	Ebb	20.0	28	3.92	69
1570	6.16	Half way across.....................	40 36 25	74 02 48	1	Ebb	20.0	28	3.91	69
1571	6.18	Half way across.....................	40 36 25	74 02 48	40	Ebb	20.0	26	4.06	72
1572	6.20	Half way across.....................	40 36 25	74 02 48	80	Ebb	20.0	26	4.06	72
1573	6.24	¾ way across from Fort Lafayette....	40 36 23	74 03 02	1	Ebb	20.0	28	3.84	68
1574	6.26	¾ way across from Fort Lafayette....	40 36 23	74 03 02	40	Ebb	20.0	26	3.98	71
1575	6.28	¾ way across from Fort Lafayette....	40 36 23	74 03 02	80	Ebb	20.0	26	3.98	71
1576	6.32	200 feet off Fort Wadsworth.........	40 36 21	74 03 12	1	Ebb	20.0	28	3.75	66
1577	6.34	200 feet off Fort Wadsworth.........	40 36 21	74 03 12	30	Ebb	20.0	26	3.89	69
1578	6.36	200 feet off Fort Wadsworth.........	40 36 21	74 03 12	60	Ebb	20.0	26	3.89	69

73—HUDSON RIVER—CROSS-SECTION BETWEEN PIER A, NEW YORK, AND C. R. R. OF N. J. FERRY, JERSEY CITY. SEPTEMBER 28, 1911

Low water occurred at Governor's Island at 6.07 A. M. High water at 12.13 P. M. Ebb currents ended about 10 A. M. Flood currents began about 10.30 A. M. Flood currents ended about 3.30 P. M. Ebb currents began about 4 P. M.
Low water at 6.07 P. M.

	A .M.									
1579	6.30	200 feet off Pier A..................	40 42 16	74 01 10	1	Ebb	20.0	42	3.01	52
1580	6.32	200 feet off Pier A..................	40 42 16	74 01 10	20	Ebb	20.0	36	3.01	52
1581	6.34	200 feet off Pier A..................	40 42 16	74 01 10	40	Ebb	20.0	34	3.01	53
1582	6.39	¼ way across from Pier A...........	40 42 17	74 01 20	1	Ebb	20.0	42	3.08	53
1583	6.41	¼ way across from Pier A...........	40 42 17	74 01 20	20	Ebb	20.0	36	3.08	54
1584	6.43	¼ way across from Pier A...........	40 42 17	74 01 20	40	Ebb	20.0	34	3.08	54
1585	6.48	Half way across.....................	40 42 19	74 01 34	1	Ebb	20.0	42	3.19	55
1586	6.50	Half way across.....................	40 42 19	74 01 34	20	Ebb	20.0	36	3.19	56

TABLE XXVII—Continued

73—HUDSON RIVER, CROSS-SECTION BETWEEN PIER A, NEW YORK, AND C. R. R. OF N. J. FERRY, JERSEY CITY. SEPTEMBER 28, 1911—Continued

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
1587	6.52	Half way across....................	40 42 19	74 01 34	40	Ebb	20.0	36	3.19	56
1588	6.57	¾ way across from Pier A...........	40 42 21	74 01 48	1	Ebb	20.0	42	3.12	54
1589	6.59	¾ way across from Pier A...........	40 42 21	74 01 48	20	Ebb	20.0	38	3.12	54
1590	7.01	¾ way across from Pier A...........	40 42 21	74 01 48	40	Ebb	20.0	36	3.12	54
1591	7.06	200 feet off C. R. R. of N. J. ferry....	40 42 22	74 01 59	1	Ebb	20.0	42	3.06	53
1592	7.08	200 feet off C. R. R. of N. J. ferry....	40 42 22	74 01 59	15	Ebb	20.0	38	3.19	55
1593	7.10	200 feet off C. R. R. of N. J. ferry....	40 42 22	74 01 59	25	Ebb	20.0	38	3.19	55
1594	8.30	200 feet off Pier A..................	40 42 16	74 01 10	1	Ebb	20.0	44	2.73	47
1595	8.32	200 feet off Pier A..................	40 42 16	74 01 10	20	Ebb	20.0	38	2.92	51
1596	8.34	200 feet off Pier A..................	40 42 16	74 01 10	40	Ebb	20.0	38	2.92	51
1597	8.39	¼ way across from Pier A...........	40 42 17	74 01 20	1	Ebb	20.0	44	2.94	50
1598	8.41	¼ way across from Pier A...........	40 42 17	74 01 20	20	Ebb	20.0	40	2.94	51
1599	8.43	¼ way across from Pier A...........	40 42 17	74 01 20	40	Ebb	20.0	38	2.94	51
1600	8.48	Half way across....................	40 42 19	74 01 34	1	Ebb	20.0	46	3.04	52
1601	8.50	Half way across....................	40 42 19	74 01 34	20	Ebb	20.0	42	3.04	52
1602	8.52	Half way across....................	40 42 19	74 01 34	40	Ebb	20.0	40	3.04	52
1603	8.57	¾ way across from Pier A...........	40 42 21	74 01 48	1	Ebb	20.0	46	3.00	51
1604	8.59	¾ way across from Pier A...........	40 42 21	74 01 48	20	Ebb	20.0	42	3.12	54
1605	9.01	¾ way across from Pier A...........	40 42 21	74 01 48	40	Ebb	20.0	40	3.12	54
1606	9.06	200 feet off C. R. R. of N. J. ferry....	40 42 22	74 01 59	1	Ebb	20.0	46	2.92	50
1607	9.08	200 feet off C. R. R. of N. J. ferry....	40 42 22	74 01 59	15	Ebb	20.0	42	3.06	53
1608	9.10	200 feet off C. R. R. of N. J. ferry....	40 42 22	74 01 59	25	Ebb	20.0	38	3.06	53
1609	10.30	200 feet off Pier A..................	40 42 16	74 01 10	1	Flood	20.0	38	2.87	50
1610	10.32	200 feet off Pier A..................	40 42 16	74 01 10	20	Flood	20.0	34	3.01	53
1611	10.34	200 feet off Pier A..................	40 42 16	74 01 10	40	Flood	20.0	34	3.01	53
1612	10.39	¼ way across from Pier A...........	40 42 17	74 01 20	1	Flood	20.0	38	3.08	53
1613	10.41	¼ way across from Pier A...........	40 42 17	74 01 20	20	Flood	20.0	36	3.08	54
1614	10.43	¼ way across from Pier A...........	40 42 17	74 01 20	40	Flood	20.0	34	3.08	54
1615	10.48	½ way across......................	40 42 19	74 01 34	1	Flood	20.0	40	3.19	55
1616	10.50	½ way across......................	40 42 19	74 01 34	20	Flood	20.0	36	3.19	56
1617	10.52	½ way across......................	40 42 19	74 01 34	40	Flood	20.0	36	3.19	56
1618	10.57	¾ way across from Pier A...........	40 42 21	74 01 48	1	Flood	20.0	42	3.27	56
1619	10.59	¾ way across from Pier A...........	40 42 21	74 01 48	20	Flood	20.0	38	3.27	57
1620	11.01	¾ way across from Pier A...........	40 42 21	74 01 48	40	Flood	20.0	38	3.27	57
1621	11.06	200 feet off C. R. R. of N. J. ferry....	40 42 22	74 01 59	1	Flood	20.0	42	3.06	53
1622	11.08	200 feet off C. R. R. of N. J. ferry....	40 42 22	74 01 59	15	Flood	20.0	38	3.19	55
1623	11.10	200 feet off C. R. R. of N. J. ferry....	40 42 22	74 01 59	25	Flood	20.0	38	3.19	55
	P. M.									
1624	12.30	200 feet off Pier A..................	40 42 16	74 01 10	1	Flood	20.0	36	3.14	55
1625	12.32	200 feet off Pier A..................	40 42 16	74 01 10	20	Flood	20.0	34	3.28	57
1626	12.34	200 feet off Pier A..................	40 42 16	74 01 10	40	Flood	20.0	34	3.28	57
1627	12.39	¼ way across from Pier A...........	40 42 17	74 01 20	1	Flood	20.0	36	3.19	56
1628	12.41	¼ way across from Pier A...........	40 42 17	74 01 20	20	Flood	20.0	34	3.36	59
1629	12.43	¼ way across from Pier A...........	40 42 17	74 01 20	40	Flood	20.0	34	3.36	59
1630	12.48	½ way across......................	40 42 19	74 01 34	1	Flood	20.0	38	3.27	57
1631	12.50	½ way across......................	40 42 19	74 01 34	20	Flood	20.0	34	3.41	60
1632	12.52	½ way across......................	40 42 19	74 01 34	40	Flood	20.0	32	3.41	60
1633	12.57	¾ way across from Pier A...........	40 42 21	74 01 48	1	Flood	20.0	40	3.33	57
1634	12.59	¾ way across from Pier A...........	40 42 21	74 01 48	20	Flood	20.0	34	3.48	61
1635	1.01	¾ way across from Pier A...........	40 42 21	74 01 48	40	Flood	20.0	32	3.48	61
1636	1.06	200 feet off C. R.R. of N. J. ferry....	40 42 22	74 01 59	1	Flood	20.0	40	3.19	55

TABLE XXVII—Continued

73—HUDSON RIVER, CROSS-SECTION BETWEEN PIER A, NEW YORK, AND C. R. R. OF N. J. FERRY, JERSEY CITY. SEPTEMBER 28, 1911—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
1637	1.08	200 feet off C. R.R. of N. J. ferry.....	40 42 22	74 01 59	15	Flood	20.0	34	3.33	58
1638	1.10	200 feet off C. R.R. of N. J. ferry.....	40 42 22	74 01 59	25	Flood	20.0	32	3.33	58
1639	2.30	200 feet off Pier A..................	40 42 16	74 01 10	1	Flood	20.0	32	3.28	58
1640	2.32	200 feet off Pier A..................	40 42 16	74 01 10	20	Flood	20.0	28	3.41	60
1641	2.34	200 feet off Pier A..................	40 42 16	74 01 10	40	Flood	20.0	28	3.41	60
1642	2.39	¼ way across from Pier A...........	40 42 17	74 01 20	1	Flood	20.0	32	3.36	59
1643	2.41	¼ way across from Pier A...........	40 42 17	74 01 20	20	Flood	20.0	28	3.50	62
1644	2.43	¼ way across from Pier A...........	40 42 17	74 01 20	40	Flood	20.0	28	3.50	62
1645	2.48	½ way across......................	40 42 19	74 01 34	1	Flood	20.0	32	3.41	60
1646	2.50	½ way across......................	40 42 19	74 01 34	20	Flood	20.0	28	3.55	63
1647	2.52	½ way across......................	40 42 19	74 01 34	40	Flood	20.0	28	3.55	63
1648	2.57	¾ way across from Pier A...........	40 42 21	74 01 48	1	Flood	20.0	34	3.48	61
1649	2.59	¾ way across from Pier A...........	40 42 21	74 01 48	20	Flood	20.0	28	3.62	64
1650	3.01	¾ way across from Pier A...........	40 42 21	74 01 48	40	Flood	20.0	28	3.62	64
1651	3.06	200 feet off C. R.R. of N. J. ferry.....	40 42 22	74 01 59	1	Flood	20.0	36	3.47	60
1652	3.08	200 feet off C. R.R. of N. J. ferry.....	40 42 22	74 01 59	15	Flood	20.0	28	3.47	61
1653	3.10	200 feet off C. R.R. of N. J. ferry.....	40 42 22	74 01 59	25	Flood	20.0	28	3.47	61
1654	4.30	200 feet off Pier A..................	40 42 16	74 01 10	1	Ebb	20.0	32	3.01	53
1655	4.32	200 feet off Pier A..................	40 42 16	74 01 10	20	Ebb	20.0	28	3.14	56
1656	4.34	200 feet off Pier A..................	40 42 16	74 01 10	40	Ebb	20.0	28	3.14	56
1657	4.39	¼ way across from Pier A...........	40 42 17	74 01 20	1	Ebb	20.0	34	3.08	54
1658	4.41	¼ way across from Pier A...........	40 42 17	74 01 20	20	Ebb	20.0	28	3.22	57
1659	4.43	¼ way across from Pier A...........	40 42 17	74 01 20	40	Ebb	20.0	28	3.22	57
1660	4.48	½ way across......................	40 42 19	74 01 34	1	Ebb	20.0	36	3.12	54
1661	4.50	½ way across......................	40 42 19	74 01 34	20	Ebb	20.0	28	3.27	58
1662	4.52	½ way across......................	40 42 19	74 01 34	40	Ebb	20.0	28	3.27	58
1663	4.57	¾ way across from Pier A...........	40 42 21	74 01 48	1	Ebb	20.0	36	3.19	56
1664	4.59	¾ way across from Pier A...........	40 42 21	74 01 48	20	Ebb	20.0	28	3.33	59
1665	5.01	¾ way across from Pier A...........	40 42 21	74 01 48	40	Ebb	20.0	28	3.33	59
1666	5.06	200 feet off C. R.R. of N. J. ferry.....	40 42 22	74 01 59	1	Ebb	20.0	36	3.06	53
1667	5.08	200 feet off C. R.R. of N. J. ferry.....	40 42 22	74 01 59	15	Ebb	20.0	30	3.19	56
1668	5.10	200 feet off C. R.R. of N. J. ferry.....	40 42 22	74 01 59	25	Ebb	20.0	30	3.19	56
6669	6.00	200 feet off Pier A..................	40 42 16	74 01 10	1	End of Ebb	20.0	38	2.73	47
1670	6.01	200 feet off Pier A..................	40 42 16	74 01 10	20	End of Ebb	20.0	32	2.92	51
1671	6.03	200 feet off Pier A..................	40 42 16	74 01 10	40	End of Ebb	20.0	32	2.92	51
1672	6.06	¼ way across from Pier A...........	40 42 17	74 01 20	1	End of Ebb	20.0	38	2.80	49
1673	6.07	¼ way across from Pier A...........	40 42 17	74 01 20	20	End of Ebb	20.0	32	2.94	52
1674	6.09	¼ way across from Pier A...........	40 42 17	74 01 20	40	End of Ebb	20.0	32	2.94	52
1675	6.13	½ way across......................	40 42 19	74 01 34	1	End of Ebb	20.0	38	3.00	52
1676	6.14	½ way across......................	40 42 19	74 01 34	20	End of Ebb	20.0	34	3.00	52
1677	6.16	½ way across......................	40 42 19	74 01 34	40	End of Ebb	20.0	34	3.00	52
1678	6.20	¾ way across from Pier A...........	40 42 21	74 01 48	1	End of Ebb	20.0	38	3.04	53
1679	6.21	¾ way across from Pier A...........	40 42 21	74 01 48	20	End of Ebb	20.0	34	3.04	53

TABLE XXVII—Continued

73—HUDSON RIVER, CROSS-SECTION BETWEEN PIER A, NEW YORK, AND C. R.R. OF N. J. FERRY, JERSEY CITY. SEPTEMBER 28, 1911—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
1680	6.23	¾ way across from Pier A...........	40 42 21	74 01 48	40	End of Ebb	20.0	34	3.04	53
1681	6.27	200 feet off C. R.R. of N. J. ferry.....	40 42 22	74 01 59	1	End of Ebb	20.0	38	2.92	51
1682	6.28	200 feet off C. R.R. of N. J. ferry......	40 42 22	74 01 59	15	End of Ebb	20.0	34	3.06	53
1683	6.30	200 feet off C. R.R. of N. J. ferry.....	40 42 22	74 01 59	25	End of Ebb	20.0	34	3.06	53

74—EAST RIVER, CROSS-SECTION BETWEEN PIER 10, MANHATTAN, AND PIER 10, BROOKLYN. SEPTEMBER 29, 1911

Low water occurred at Governor's Island at 6.57 A. M. High water at 12.53 P. M. Low water at 7.27 P. M. Slack water from 8 A. M. to 8.30 A. M. Flood currents began about 8.30 A. M. Flood currents ended about 2.30 P. M. Ebb currents began about 3 P. M.

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
	A. M.									
1684	7.30	100 feet off Pier 10, Manhattan........	40 42 09	74 00 22	1	Ebb	20.0	30	2.73	48
1685	7.32	100 feet off Pier 10, Manhattan........	40 42 09	74 00 22	20	Ebb	20.0	28	2.87	51
1686	7.34	100 feet off Pier 10, Manhattan........	40 42 09	74 00 22	30	Ebb	20.0	28	2.87	51
1687	7.38	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	1	Ebb	20.0	30	2.80	49
1688	7.40	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	20	Ebb	20.0	28	2.94	52
1689	7.42	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	40	Ebb	20.0	28	2.94	52
1690	7.46	Half way across....................	40 42 03	74 00 11	1	Ebb	20.0	32	2.92	51
1691	7.48	Half way across....................	40 42 03	74 00 11	20	Ebb	20.0	28	3.04	54
1692	7.50	Half way across....................	40 42 03	74 00 11	40	Ebb	20.0	28	3.04	54
1693	7.54	¾ way across from Pier 10, Manhattan	40 42 00	74 00 05	1	Ebb	20.0	32	2.84	50
1694	7.56	¾ way across from Pier 10, Manhattan	40 42 00	74 00 05	20	Ebb	20.0	28	3.00	53
1695	7.58	¾ way across from Pier 10, Manhattan	40 42 00	74 00 05	35	Ebb	20.0	28	3.00	53
1696	8.02	100 feet off Pier 10, Brooklyn........	40 41 57	74 00 00	1	Ebb	20.0	32	2.79	49
1697	8.04	100 feet off Pier 10, Brooklyn........	40 41 57	74 00 00	20	Ebb	20.0	28	2.92	52
1698	8.06	100 feet off Pier 10, Brooklyn........	40 41 57	74 00 00	35	Ebb	20.0	28	2.92	52
1699	9.30	100 feet off Pier 10, Manhattan.......	40 42 09	74 00 22	1	Flood	20.0	34	3.01	53
1700	9.32	100 feet off Pier 10, Manhattan.......	40 42 09	74 00 22	20	Flood	20.0	30	3.14	55
1701	9.34	100 feet off Pier 10, Manhattan.......	40 42 09	74 00 22	30	Flood	20.0	30	3.14	55
1702	9.38	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	1	Flood	20.0	34	3.08	54
1703	9.40	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	20	Flood	20.0	30	3.19	56
1704	9.42	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	40	Flood	20.0	30	3.19	56
1705	9.46	Half way across....................	40 42 03	74 00 11	1	Flood	20.0	34	3.19	56
1706	9.48	Half way across....................	40 42 03	74 00 11	20	Flood	20.0	30	3.19	56
1707	9.50	Half way across....................	40 42 03	74 00 11	40	Flood	20.0	30	3.19	56
1708	9.54	¾ way across from Pier 10, Manhattan	40 42 00	74 00 05	1	Flood	20.0	32	3.12	55
1709	9.56	¾ way across from Pier 10, Manhattan	40 42 00	74 00 05	20	Flood	20.0	30	3.12	55
1710	9.58	¾ way across from Pier 10, Manhattan	40 42 00	74 00 05	35	Flood	20.0	30	3.12	55
1711	10.02	100 feet off Pier 10, Brooklyn..........	40 41 57	74 00 00	1	Flood	20.0	32	2.73	48
1712	10.04	100 feet off Pier 10, Brooklyn..........	40 41 57	74 00 00	20	Flood	20.0	30	2.92	51
1713	10.06	100 feet off Pier 10, Brooklyn..........	40 41 57	74 00 00	35	Flood	20.0	20	2.92	51
	P. M.									
1714	12.30	100 feet off Pier 10, Manhattan........	40 42 09	74 00 22	1	Flood	20.0	30	3.14	55
1715	12.32	100 feet off Pier 10, Manhattan........	40 42 09	74 00 22	20	Flood	20.0	28	3.28	58
1716	12.34	100 feet off Pier 10, Manhattan........	40 42 09	74 00 22	30	Flood	20.0	28	3.28	58
1717	12.40	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	1	Flood	20.0	30	3.19	56
1718	12.42	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	20	Flood	20.0	28	3.36	60
1719	12.44	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	40	Flood	20.0	28	3.36	60

TABLE XXVII—Continued

74—EAST RIVER, CROSS-SECTION BETWEEN PIER 10, MANHATTAN, AND PIER 10, BROOKLYN. SEPTEMBER 29, 1911—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. satura-tion
			° ′ ″	° ′ ″						
1720	12.49	Half way across....................	40 42 03	74 00 11	1	Flood	20.0	30	3.33	59
1721	12.51	Half way across....................	40 42 03	74 00 11	20	Flood	20.0	28	3.33	59
1722	12.53	Half way across....................	40 42 03	74 00 11	40	Flood	20.0	28	3.33	59
1723	12.57	¾ way across from Pier 10, Manhattan	40 42 00	74 00 05	1	Flood	20.0	28	3.27	58
1724	12.59	¾ way across from Pier 10, Manhattan	40 42 00	74 00 05	20	Flood	20.0	28	3.27	58
1725	1.01	¾ way across from Pier 10, Manhattan	40 42 00	74 00 05	35	Flood	20.0	28	3.27	58
1726	1.05	100 feet off Pier 10 Brooklyn..........	40 41 57	74 00 00	1	Flood	20.0	28	3.06	54
1727	1.07	100 feet off Pier 10, Brooklyn..........	40 41 57	74 00 00	20	Flood	20.0	28	3.19	57
1728	1.09	100 feet off Pier 10, Brooklyn..........	40 41 57	74 00 00	35	Flood	30.0	28	3.19	57
1729	2.30	100 feet off Pier 10, Manhattan........	40 42 09	74 00 22	1	Flood	20.0	28	3.28	58
1730	2.32	100 feet off Pier 10, Manhattan........	40 42 09	74 00 22	20	Flood	20.0	28	3.28	58
1731	2.34	100 feet off Pier 10, Manhattan........	40 42 09	74 .00 22	30	Flood	20.0	28	3.28	58
1732	2.38	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	1	Flood	20.0	28	3.36	60
1733	2.40	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	20	Flood	20.0	28	3.36	60
1734	2.42	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	40	Flood	20.0	28	3.36	60
1735	2.46	Half way across....................	40 42 03	74 00 11	1	Flood	20.0	28	3.33	59
1736	2.48	Half way across....................	40 42 03	74 00 11	20	Flood	20.0	28	3.33	59
1737	2.50	Half way across....................	40 42 03	74 00 11	40	Flood	20.0	28	3.33	59
1738	2.54	¾ way across from Pier 10, Manhattan	40 42 00	74 00 05	1	Flood	20.0	28	3.27	58
1739	2.56	¾ way across from Pier 10, Manhattan	40 42 00	74 00 05	20	Flood	20.0	28	3.27	58
1740	2.58	¾ way across from Pier 10, Manhattan	40 42 00	74 00 05	35	Flood	20.0	28	3.27	58
1741	3.02	100 feet off Pier 10, Brooklyn..........	40 41 57	74 00 00	1	Flood	20.0	28	3.19	57
1742	3.04	100 feet off Pier 10, Brooklyn..........	40 41 57	74 00 00	20	Flood	20.0	28	3.19	57
1743	3.06	100 feet off Pier 10, Brooklyn..........	40 41 57	74 00 00	35	Flood	20.0	28	3.19	57
1744	4.30	100 feet off Pier 10, Manhattan.......	40 42 09	74 00 22	1	Ebb	20.0	30	2.87	51
1745	4.32	100 feet off Pier 10, Manhattan.......	40 42 09	74 00 22	20	Ebb	20.0	28	2.87	51
1746	4.34	100 feet off Pier 10, Manhattan.......	40 42 09	74 00 22	30	Ebb	20.0	28	2.87	51
1747	4.38	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	1	Ebb	20.0	30	2.94	52
1748	4.40	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	20	Ebb	20.0	28	3.08	55
1749	4.42	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	40	Ebb	20.0	28	3.08	55
1750	4.46	½ way across......................	40 42 03	74 00 11	1	Ebb	20.0	28	3.04	54
1751	4.48	½ way across......................	40 42 03	74 00 11	20	Ebb	20.0	28	3.19	57
1752	4.50	½ way across......................	40 42 03	74 00 11	40	Ebb	20.0	28	3.19	57
1753	4.54	¾ way across from Pier 10, Manhattan	40 42 00	74 00 05	1	Ebb	20.0	28	3.00	53
1754	4.56	¾ way across from Pier 10, Manhattan	40 42 00	74 00 05	20	Ebb	20.0	28	3.12	55
1755	4.58	¾ way across from Pier 10, Manhattan	40 42 00	74 00 05	35	Ebb	20.0	28	3.12	55
1756	5.02	100 feet off Pier 10, Brooklyn........	40 41 57	74 00 00	1	Ebb	20.0	28	2.92	52
1757	5.04	100 feet off Pier 10, Brooklyn........	40 41 57	74 00 00	20	Ebb	20.0	28	2.92	52
1758	5.06	100 feet off Pier 10, Brooklyn........	40 41 47	74 00 00	35	Ebb	20.0	28	2.92	52
1759	6.00	100 feet off Pier 10, Manhattan.......	40 42 09	74 00 22	1	Ebb	20.0	30	2.73	48
1760	6.01	100 feet off Pier 10, Manhattan.......	40 42 09	74 00 22	20	Ebb	20.0	28	2.87	51
1761	6.03	100 feet off Pier 10, Manhattan.......	40 42 09	74 00 22	30	Ebb	20.0	28	2.87	51
1762	6.06	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	1	Ebb	20.0	30	2.94	52
1763	6.07	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	20	Ebb	20.0	28	2.94	52
1764	6.09	¼ way across from Pier 10, Manhattan	40 42 07	74 00 17	40	Ebb	20.0	28	2.94	52
1765	6.13	½ way across......................	40 42 03	74 00 11	1	Ebb	20.0	30	3.04	54
1766	6.14	½ way across......................	40 42 03	74 00 11	20	Ebb	20.0	28	3.04	54
1767	6.16	½ way across......................	40 42 03	74 00 11	40	Ebb	20.0	28	3.04	54
1768	6.20	¾ way across from Pier 10, Manhattan	40 42 00	74 00 05	1	Ebb	20.0	30	3.00	53
1769	6.21	¾ way across from Pier 10, Manhattan	40 42 00	74 00 05	20	Ebb	20.0	28	3.00	53
1770	6.23	¾ way across from Pier 10, Manhattan	40 42 00	74 00 05	35	Ebb	20.0	28	3.00	53
1771	6.27	100 feet off Pier 10, Brooklyn........	40 41 57	74 00 00	1	Ebb	20.0	30	2.79	49
1772	6.28	100 feet off Pier 10, Brooklyn........	40 41 57	74 00 00	20	Ebb	20.0	28	2.92	52
1773	6.30	100 feet off Pier 10, Brooklyn........	40 41 57	74 00 00	35	Ebb	20.0	28	2.92	52

TABLE XXVII—Continued

75—KILL VAN KULL, CROSS-SECTION AT NEW BRIGHTON, STATEN ISLAND. OCTOBER 4, 1911

High water occurred at Governor's Island at 5.02 A. M. Low water at 11.18 A. M. High water at 5.20 P. M.

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
1774	7.30	100 feet off Jersey street, New Brighton	40 38 51	75 04 24	1	Flood	18.0	30	4.10	70
1775	7.32	100 feet off Jersey street, New Brighton	40 38 51	74 05 24	15	Flood	18.0	28	4.38	74
1776	7.34	100 feet off Jersey street, New Brighton	40 38 51	74 05 24	30	Flood	18.0	28	4.65	79
1777	7.39	Midway across	40 38 57	74 05 25	1	Flood	18.0	30	4.20	71
1778	7.41	Midway across	40 38 57	74 05 25	20	Flood	18.0	28	4.49	76
1779	7.43	Midway across	40 38 57	74 05 25	40	Flood	18.0	28	4.78	81
1780	7.48	100 feet off Columbia Oil Co. pier (old)	40 39 02	74 05 26	1	Flood	18.0	32	4.17	71
1781	7.50	100 feet off Columbia Oil Co. pier (old)	40 39 02	74 05 26	15	Flood	18.0	30	4.44	75
1782	7.52	100 feet off Columbia Oil Co. pier (old)	40 39 02	74 05 26	25	Flood	18.0	30	4.72	80
1783	9.30	100 feet off Jersey street, New Brighton	40 38 51	74 05 24	1	Ebb	18.0	34	4.38	74
1784	9.32	100 feet off Jersey street, New Brighton	40 38 51	74 05 24	15	Ebb	17.0	34	4.38	74
1785	9.34	100 feet off Jersey street, New Brighton	40 38 51	74 05 24	30	Ebb	17.0	32	4.38	74
1786	9.39	Midway across	40 38 57	74 05 25	1	Ebb	18.0	34	4.48	76
1787	9.41	Midway across	40 38 57	74 05 25	20	Ebb	17.0	32	4.49	76
1788	9.43	Midway across	40 38 57	74 05 25	40	Ebb	17.0	32	4.49	76
1789	9.48	100 feet off Columbia Oil Co. pier (old)	40 39 02	74 05 26	1	Ebb	18.0	34	4.44	75
1790	9.50	100 feet off Columbia Oil Co. pier (old)	40 39 02	74 05 26	15	Ebb	17.0	32	4.58	78
1791	9.52	100 feet off Columbia Oil Co. pier (old)	40 39 02	74 05 26	25	Ebb	17.0	32	4.58	78
1792	11.30	100 feet off Jersey street, New Brighton	40 38 51	74 05 24	1	Ebb	18.0	36	4.10	68
1793	11.32	100 feet off Jersey street, New Brighton	40 38 51	74 05 24	15	Ebb	18.0	34	4.38	73
1794	11.34	100 feet off Jersey street, New Brighton	40 38 51	74 05 24	30	Ebb	17.5	34	4.38	73
1795	11.39	Midway across	40 38 57	74 05 25	1	Ebb	18.0	36	4.26	71
1796	11.41	Midway across	40 38 57	74 05 25	20	Ebb	17.5	34	4.55	76
1797	11.43	Midway across	40 38 57	74 05 25	40	Ebb	17.5	34	4.55	76
1798	11.48	100 feet off Columbia Oil Co. pier (old)	40 39 02	74 05 26	1	Ebb	18.0	36	4.17	69
1799	11.50	100 feet off Columbia Oil Co. pier (old)	40 39 02	74 05 26	15	Ebb	17.5	34	4.44	74
1800	11.52	100 feet off Columbia Oil Co. pier (old)	40 39 02	74 05 26	25	Ebb	17.5	34	4.44	74
	P. M.									
1801	1.30	100 feet off Jersey street, New Brighton	40 38 51	74 05 24	1	Flood	18.0	34	4.10	68
1802	1.32	100 feet off Jersey street, New Brighton	40 38 51	74 05 24	15	Flood	17.5	32	4.38	73
1803	1.34	100 feet off Jersey street, New Brighton	40 38 51	74 05 24	30	Flood	17.5	32	4.38	73
1804	1.39	Midway across	40 38 57	74 05 25	1	Flood	18.0	34	4.26	71
1805	1.41	Midway across	40 38 57	74 05 25	20	Flood	17.5	30	4.55	76
1806	1.43	Midway across	40 38 57	74 05 25	40	Flood	17.5	30	4.55	76
1807	1.48	100 feet off Columbia Oil Co. pier (old)	40 39 02	74 05 26	1	Flood	18.0	32	4.44	75
1808	1.50	100 feet off Columbia Oil Co. pier (old)	40 39 02	74 05 26	15	Flood	17.5	30	4.58	76
1809	1.52	100 feet off Columbia Oil Co. pier (old)	40 39 02	74 05 26	25	Flood	17.5	30	4.58	76
1810	3.30	100 feet off Jersey street, New Brighton	40 38 51	74 05 24	1	Flood	18.5	28	4.10	70
1811	3.32	100 feet off Jersey street, New Brighton	40 38 51	74 05 24	15	Flood	18.5	26	4.38	74
1812	3.34	100 feet off Jersey street, New Brighton	40 38 51	74 05 24	30	Flood	18.5	26	4.38	74
1813	3.39	Midway across	40 38 57	74 05 25	1	Flood	18.5	28	4.17	71
1814	3.41	Midway across	40 38 57	74 05 25	20	Flood	18.5	26	4.44	75
1815	3.43	Midway across	40 38 57	74 05 25	40	Flood	18.5	26	4.44	75
1816	3.48	100 feet off Columbia Oil Co. pier (old)	40 39 02	74 05 26	1	Flood	18.5	28	4.26	72
1817	3.50	100 feet off Columbia Oil Co. pier (old)	40 39 02	74 05 26	15	Flood	18.5	26	4.40	74
1818	3.52	100 feet off Columbia Oil Co. pier (old)	40 39 02	74 05 26	25	Flood	18.5	26	4.26	72
1819	5.30	100 feet off Jersey street, New Brighton	40 38 51	74 05 24	1	Flood	18.5	28	4.38	74
1820	5.32	100 feet off Jersey street, New Brighton	40 38 51	74 05 24	15	Flood	18.5	26	4.65	79
1821	5.34	100 feet off Jersey street, New Brighton	40 38 51	74 05 24	30	Flood	18.5	26	4.65	79
1822	5.39	Midway across	40 38 57	74 05 25	1	Flood	18.5	26	4.44	75
1823	5.41	Midway across	40 38 57	74 05 25	20	Flood	18.5	24	4.72	80
1824	5.43	Midway across	40 38 57	74 05 25	40	Flood	18.5	24	4.72	80
1825	5.48	100 feet off Columbia Oil Co. pier	40 39 02	74 05 26	1	Flood	18.5	26	4.54	77
1826	5.50	100 feet off Columbia Oil Co. pier	40 39 02	74 05 26	15	Flood	18.5	24	4.69	79
1827	5.52	100 feet off Columbia Oil Co. pier	40 39 02	74 05 26	25	Flood	18.5	24	4.69	79

TABLE XXVII—Continued

76—NEWARK BAY, CROSS-SECTION JUST BELOW C. R.R. OF N. J. TRESTLE. OCTOBER 6, 1911

High water occurred at Governor's Island at 6.20 A. M. Low water at 12.45 P. M. High water at 6.35 P. M.

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
1828	8.00	300 feet off east shore (Bayonne)	40 39 17	74 08 27	1	Ebb	15.5	40	3.88	62
1829	8.02	300 feet off east shore (Bayonne)	40 39 17	74 08 27	10	Flood	16.0	32	3.88	74
1830	8.06	In channel, near draw	40 39 17	74 08 46	1	Ebb	15.5	40	3.84	61
1831	8.08	In channel, near draw	40 39 17	74 08 46	15	Flood	16.0	36	4.12	66
1832	8.10	In channel, near draw	40 39 17	74 08 46	30	Flood	16.0	36	3.70	60
1833	8.14	½ way across bay	40 39 17	74 09 14	1	Ebb	15.5	40	3.89	62
1834	8.16	½ way across bay	40 39 17	74 09 14	8	Ebb	16.0	38	3.89	63
1835	8.20	¾ way across from east shore	40 39 17	74 09 40	1	Ebb	15.5	40	3.83	61
1836	8.22	¾ way across from east shore	40 39 17	74 09 40	8	Ebb	16.0	38	3.83	62
1837	8.26	300 feet off west shore	40 39 18	74 10 02	1	Ebb	15.5	40	3.92	62
1838	8.28	300 feet off west shore	40 39 18	74 10 02	8	Ebb	15.5	38	3.92	63
1839	10.00	300 feet off east shore	40 39 17	74 08 27	1	Ebb	15.5	44	4.48	71
1840	10.02	300 feet off east shore	40 39 17	74 08 27	9	Ebb	16.0	40	4.48	71
1841	10.06	In channel, near draw	40 39 17	74 08 46	1	Ebb	16.0	40	4.26	68
1842	10.08	In channel, near draw	40 39 17	74 08 46	15	Ebb	16.0	40	4.40	70
1843	10.10	In channel, near draw	40 39 17	74 08 46	30	Ebb	16.0	40	4.26	68
1844	10.14	½ way across bay	40 39 17	74 09 14	1	Flood	15.5	40	4.17	66
1845	10.16	½ way across bay	40 39 17	74 09 14	7	Flood	16.0	40	4.17	66
1846	10.20	¾ way across from east shore	40 39 17	74 09 40	1	Flood	15.5	40	4.10	65
1847	10.22	¾ way across from east shore	40 39 17	74 09 40	7	Flood	16.0	40	4.10	65
1848	10.26	300 feet off west shore	40 39 18	74 10 02	1	Flood	15.5	40	4.06	65
1849	10.28	300 feet off west shore	40 39 18	74 10 02	7	Flood	15.5	40	4.06	65
1850	12.00	300 feet off east shore	40 39 17	74 08 27	1	Flood	16.0	46	4.18	66
1851	P. M. 12.02	300 feet off east shore	40 39 17	74 08 27	8	Flood	16.0	44	4.32	69
1852	12.04	In channel, near draw	40 39 17	74 08 46	1	Flood	16.0	46	4.26	68
1853	12.06	In channel, near draw	40 39 17	74 08 46	15	Flood	16.0	44	4.26	68
1854	12.08	In channel, near draw	40 39 17	74 08 46	30	Flood	16.0	42	4.26	68
1855	12.12	½ way across bay	40 39 17	74 09 14	1	Flood	16.0	48	4.44	70
1856	12.14	½ way across bay	40 39 17	74 09 14	6	Flood	16.0	46	4.58	73
1857	12.18	¾ way across from east shore	40 39 17	74 09 40	1	Flood	16.0	48	4.51	71
1858	12.20	¾ way across from east shore	40 39 17	74 09 40	6	Flood	16.0	48	4.38	70
1859	12.24	300 feet off west shore	40 39 18	74 10 02	1	Ebb	16.0	48	4.48	71
1860	12.26	300 feet off west shore	40 39 18	74 10 02	6	Ebb	16.0	48	4.48	71
1861	2.00	300 feet off east shore	40 39 17	74 08 27	1	Ebb	16.0	54	4.48	70
1862	2.02	300 feet off east shore	40 39 17	74 08 27	8	Ebb	16.0	54	4.48	70
1863	2.04	In channel, near draw	40 39 17	74 08 46	1	Ebb	16.0	54	4.26	67
1864	2.06	In channel, near draw	40 39 17	74 08 46	15	Ebb	16.0	52	4.26	67
1865	2.08	In channel, near draw	40 39 17	74 08 46	30	Ebb	16.0	50	4.26	67
1866	2.12	½ way across	40 39 17	74 09 14	1	Ebb	16.0	54	4.17	65
1867	2.14	½ way across	40 39 17	74 09 14	6	Ebb	16.0	54	4.17	65
1868	2.18	¾ way across from east shore	40 39 17	74 09 40	1	Ebb	16.0	54	4.10	64
1869	2.20	¾ way across from east shore	40 39 17	74 09 40	6	Ebb	16.0	54	4.10	64
1870	2.24	300 feet off west shore	40 39 18	74 10 02	1	Ebb	16.0	54	4.20	66
1871	2.26	300 feet off west shore	40 39 18	74 10 02	6	Ebb	16.0	54	4.20	66
1872	3.30	300 feet off east shore	40 39 17	74 08 27	1	Flood	15.5	48	3.88	61
1873	3.32	300 feet off east shore	40 39 17	74 08 27	8	Flood	15.5	46	3.88	61
1874	3.36	In channel, near draw	40 39 17	74 08 46	1	Flood	15.5	48	3.84	60
1875	3.38	In channel, near draw	40 39 17	74 08 46	15	Flood	15.5	46	3.84	60
1876	3.40	In channel, near draw	40 39 17	74 08 46	30	Flood	15.5	44	4.12	64
1877	3.44	½ way across	40 39 17	74 09 14	1	Flood	15.5	46	3.89	61

TABLE XXVII—Continued

76—NEWARK BAY, CROSS-SECTION JUST BELOW C. R.R. OF N. J. TRESTLE. OCTOBER 6, 1911—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
1878	3.46	½ way across	40 39 17	74 09 14	7	Flood	15.5	44	3.89	61
1879	3.50	¾ way across	40 39 17	74 09 40	1	Flood	15.5	46	3.83	60
1880	3.52	¾ way across	40 39 17	74 09 40	7	Flood	15.5	46	3.83	60
1881	3.56	300 feet off west shore	40 39 18	74 10 02	1	Flood	15.5	46	3.92	61
1882	3.58	300 feet off west shore	40 39 18	74 10 02	7	Flood	15.5	46	3.92	61
1883	5.00	300 feet off east shore	40 39 17	74 08 27	1	Flood	15.5	40	3.88	62
1884	5.02	300 feet off east shore	40 39 17	74 08 27	8	Flood	15.5	40	3.88	62
1885	5.06	In channel, near draw	40 39 17	74 08 46	1	Flood	15.5	40	3.72	60
1886	5.08	In channel, near draw	40 39 17	74 08 46	15	Flood	15.5	38	3.84	61
1887	5.10	In channel, near draw	40 39 17	74 08 46	30	Flood	15.5	38	3.98	63
1888	5.14	½ way across	40 39 17	74 09 14	1	Flood	15.5	38	3.61	57
1889	5.16	½ way across	40 39 17	74 09 14	8	Flood	15.5	38	3.61	57
1890	5.20	¾ way across	40 39 17	74 09 40	1	Flood	15.5	38	3.55	56
1891	5.22	¾ way across	40 39 17	74 09 40	8	Flood	15.5	38	3.55	56
1892	5.26	300 feet off west shore	40 39 18	74 10 02	1	Flood	15.5	38	3.64	58
1893	5.28	300 feet off west shore	40 39 18	74 10 02	8	Flood	15.5	38	3.64	58

77—EAST RIVER, CROSS-SECTION BETWEEN LAWRENCE POINT AND STONY POINT. OCTOBER 11, 1911

High water occurred at Governor's Island at 9.50 A. M. Hell Gate, low water at 5.15 A. M. High water at 11.40 A. M. Low water at 6.10 P. M. Flood currents began about 7.15 A. M. Flood currents ended about 12.15 P. M. Ebb currents began about 12.30 P. M.

	A. M.									
1894	7.50	By buoy 7, near Lawrence Point	40 47 34	73 54 30	1	Flood	16.5	26	3.28	55
1895	7.52	By buoy 7, near Lawrence Point	40 47 34	73 54 30	20	Flood	16.5	26	3.28	55
1896	7.54	By buoy 7, near Lawrence Point	40 47 34	73 54 30	40	Flood	16.5	26	3.28	55
1897	7.58	½ way across	40 47 45	73 54 31	1	Flood	16.5	26	3.27	55
1898	8.00	½ way across	40 47 45	73 54 31	35	Flood	16.5	26	3.27	55
1899	8.02	½ way across	40 47 45	73 54 31	70	Flood	16.5	26	3.27	55
1900	8.06	200 feet off East 134th st. ferry (Stony Point)	40 47 56	73 54 31	1	Flood	16.5	26	3.33	56
1901	8.08	200 feet off East 134th st. ferry (Stony Point)	40 47 56	73 54 31	35	Flood	16.5	26	3.33	56
1902	8.10	200 feet off East 134th st. ferry (Stony Point)	40 47 56	73 54 31	70	Flood	16.5	26	3.33	56
1903	10.00	By buoy 7, near Lawrence Point	40 47 34	73 54 30	1	Flood	16.5	30	3.14	52
1904	10.02	By buoy 7, near Lawrence Point	40 47 34	73 54 30	20	Flood	16.5	28	3.28	54
1905	10.04	By buoy 7, near Lawrence Point	40 47 34	73 54 30	40	Flood	16.5	28	3.28	54
1906	10.08	Half way across	40 47 45	73 54 31	1	Flood	16.5	30	3.12	52
1907	10.10	Half way across	40 47 45	73 54 31	35	Flood	16.5	28	3.41	56
1908	10.12	Half way across	40 47 45	73 54 31	70	Flood	16.5	28	3.41	56
1909	10.16	200 feet off East 134th st. ferry	40 47 56	73 54 31	1	Flood	16.5	30	3.19	53
1910	10.18	200 feet off East 134th st. ferry	40 47 56	73 54 31	35	Flood	16.5	28	3.33	55
1911	10.20	200 feet off East 134th st. ferry	40 47 56	73 54 31	70	Flood	16.5	28	3.33	55
	P. M.									
1912	12.00	By buoy 7, near Lawrence Point	40 47 34	73 54 30	1	Flood	16.5	36	3.14	51
1913	12.02	By buoy 7, near Lawrence Point	40 47 34	73 54 30	20	Flood	16.0	32	3.28	54
1914	12.04	By buoy 7, near Lawrence Point	40 47 34	73 54 30	40	Flood	16.0	32	3.28	54
1915	12.08	Half way across	40 47 45	73 54 31	1	Flood	16.5	36	3.12	50
1916	12.10	Half way across	40 47 45	73 54 31	35	Flood	16.0	32	3.41	56
1917	12.12	Half way across	40 47 45	73 54 31	70	Flood	16.0	32	3.41	56

TABLE XXVII—Continued

77—EAST RIVER, CROSS-SECTION BETWEEN LAWRENCE POINT AND STONY POINT. OCTOBER 11, 1911—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
1918	12.16	200 feet off East 134th st. ferry.......	40 47 56	73 54 31	1	Flood	16.5	36	3.19	51
1919	12.18	200 feet off East 134th st. ferry.......	40 47 56	73 54 31	35	Flood	16.0	32	3.33	55
1920	12.20	200 feet off East 134th st. ferry.......	40 47 56	73 54 31	70	Flood	16.0	32	3.33	55
1921	2.00	By buoy 7, near Lawrence Point......	40 47 34	73 54 30	1	Ebb	16.5	28	3.28	54
1922	2.02	By buoy 7, near Lawrence Point......	40 47 34	73 54 30	20	Ebb	16.5	28	3.28	54
1923	2.04	By buoy 7, near Lawrence Point......	40 47 34	73 54 30	40	Ebb	16.5	28	3.28	54
1924	2.08	Half way across....................	40 47 45	73 54 31	1	Ebb	16.5	28	3.29	54
1925	2.10	Half way across....................	40 47 45	73 54 31	35	Ebb	16.5	28	3.41	56
1926	2.12	Half way across....................	40 47 45	73 54 31	70	Ebb	16.5	28	3.41	56
1927	2.16	200 feet off East 134th st. ferry.......	40 47 56	73 54 31	1	Ebb	16.5	28	3.33	55
1928	2.18	200 feet off East 134th st. ferry.......	40 47 56	73 54 31	35	Ebb	16.5	28	3.33	55
1929	2.20	200 feet off East 134th st. ferry.......	40 47 56	73 54 31	70	Ebb	16.5	28	3.33	55
1930	4.00	By buoy 7 near Lawrence Point.......	40 47 34	73 54 30	1	Ebb	16.0	24	3.55	59
1931	4.02	By buoy 7, near Lawrence Point.......	40 47 34	73 54 30	20	Ebb	16.0	24	3.69	62
1932	4.04	By buoy 7, near Lawrence Point.......	40 47 34	73 54 30	40	Ebb	16.0	24	3.69	62
1933	4.08	½ way across.....................	40 47 45	73 54 31	1	Ebb	16.0	24	3.70	62
1934	4.10	½ way across.....................	40 47 45	73 54 31	35	Ebb	16.0	24	3.84	64
1935	4.12	½ way across.....................	40 47 45	73 54 31	70	Ebb	16.0	24	3.84	64
1936	4.16	200 feet off East 134th street ferry.....	40 47 56	73 54 31	1	Ebb	16.0	24	3.61	60
1937	4.18	200 feet off East 134th street ferry.....	40 47 56	73 54 31	35	Ebb	16.0	24	3.75	63
1938	4.20	200 feet off East 134th street ferry.....	40 47 56	73 54 31	70	Ebb	16.0	24	3.75	63
1939	5.00	By buoy 7, near Lawrence Point.......	40 47 34	73 54 30	1	Ebb	16.0	24	3.55	59
1940	5.02	By buoy 7, near Lawrence Point.......	40 47 34	73 54 30	20	Ebb	16.0	24	3.69	62
1941	5.04	By buoy 7, near Lawrence Point.......	40 47 34	73 54 30	40	Ebb	16.0	24	3.69	62
1942	5.08	½ way across.....................	40 47 45	73 54 31	1	Ebb	16.0	24	3.70	62
1943	5.10	½ way across.....................	40 47 45	73 54 31	35	Ebb	16.0	24	3.84	64
1944	5.12	½ way across.....................	40 47 45	73 54 31	70	Ebb	16.0	24	3.84	64
1945	5.16	200 feet off East 134th street ferry.....	40 47 56	73 54 31	1	Ebb	16.0	24	3.61	60
1946	5.18	200 feet off East 134th street ferry.....	40 47 56	73 54 31	35	Ebb	16.0	24	3.75	63
1947	5.20	200 feet off East 134th street ferry.....	40 47 56	73 54 31	70	Ebb	16.0	24	3.75	63

78—HUDSON RIVER, CROSS-SECTION AT MT. ST. VINCENT. OCTOBER 13, 1911

Low water occurred at Governor's Island at 5.15 A. M. High water at 11.32 A. M. Mt. St. Vincent—Low water at 7.15 A. M. High water at 1.45 P. M. Ebb currents ended about 10.15 P. M. Flood currents began about 10.30 A. M. Ebb currents began about 3.15 P. M.

	A. M.									
1948	7.45	500 feet off Mt. St. Vincent..........	40 54 50	73 54 49	1	Ebb	15.5	80	5.74	84
1949	7.47	500 feet off Mt. St. Vincent..........	40 54 50	73 54 49	20	Ebb	15.0	60	5.19	78
1950	7.49	500 feet off Mt. St. Vincent..........	40 54 50	73 54 49	40	Ebb	15.0	58	5.19	78
1951	7.53	¼ way across from east shore........	40 54 50	73 54 59	1	Ebb	15.5	80	5.83	85
1952	7.55	¼ way across from east shore........	40 54 50	73 54 59	20	Ebb	15.0	60	5.28	79
1953	7.57	¼ way across from east shore........	40 54 50	73 54 59	40	Ebb	15.0	58	5.28	79
1954	8.01	½ way across.....................	40 54 50	73 55 15	1	Ebb	15.5	78	5.88	86
1955	8.03	½ way across.....................	40 54 50	73 55 15	20	Ebb	15.0	68	5.60	83
1956	8.05	½ way across.....................	40 54 50	73 55 15	35	Ebb	15.0	66	5.60	84
1957	8.09	¾ way across from east shore........	40 54 50	73 55 30	1	Ebb	15.5	76	5.97	88
1958	8.11	¾ way across from east shore........	40 54 50	73 55 30	10	Ebb	15.0	72	5.68	84
1959	8.13	¾ way across from east shore........	40 54 50	73 55 30	20	Ebb	15.0	72	5.68	84

TABLE XXVII—Continued

78—HUDSON RIVER, CROSS-SECTION AT MT. ST. VINCENT. OCTOBER 13, 1911—Continued

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
1960	8.17	500 feet off west shore	40 54 50	73 55 42	1	Ebb	15.5	76	5.94	87
1961	8.19	500 feet off west shore	40 54 50	73 55 42	10	Ebb	15.5	74	5.65	83
1962	8.21	500 feet off west shore	40 54 50	73 55 42	15	Ebb	15.5	74	5.65	83
1963	9.45	500 feet off Mt. St. Vincent	40 54 50	73 54 49	1	Ebb	15.5	76	5.74	84
1964	9.47	500 feet off Mt. St. Vincent	40 54 50	73 54 49	20	Ebb	15.5	68	5.19	77
1965	9.49	500 feet off Mt. St. Vincent	40 54 50	73 54 49	40	Ebb	15.5	68	5.19	77
1966	9.53	¼ way across from east shore	40 54 50	73 54 59	1	Ebb	15.5	76	5.83	86
1967	9.55	¼ way across from east shore	40 54 50	73 54 59	20	Ebb	15.5	68	5.28	79
1968	9.57	¼ way across from east shore	40 54 50	73 54 59	40	Ebb	15.5	68	5.28	79
1969	10.01	½ way across	40 54 50	73 55 15	1	Ebb	15.5	76	5.88	87
1970	10.03	½ way across	40 54 50	73 55 15	20	Ebb	15.5	68	5.60	84
1971	10.05	½ way across	40 54 50	73 55 15	35	Ebb	15.5	68	5.60	84
1972	10.09	¾ way across from east shore	40 54 50	73 55 30	1	Ebb	15.5	76	5.97	88
1973	10.11	¾ way across from east shore	40 54 50	73 55 30	10	Ebb	15.5	70	5.68	85
1974	10.13	¾ way across from east shore	40 54 50	73 55 30	20	Ebb	15.5	70	5.68	85
1975	10.17	500 feet off west shore	40 54 50	73 55 42	1	Ebb	15.5	76	5.94	87
1976	10.19	500 feet off west shore	40 54 50	73 55 42	10	Ebb	15.5	72	5.65	84
1977	10.21	500 feet off west shore	40 54 50	73 55 42	15	Ebb	15.5	70	5.65	84
1978	11.45	500 feet off Mt. St. Vincent	40 54 50	73 54 49	1	Flood	15.5	70	4.94	74
1979	11.47	500 feet off Mt. St. Vincent	40 54 50	73 54 49	20	Flood	15.5	66	4.78	73
1980	11.49	500 feet off Mt. St. Vincent	40 54 50	73 54 49	40	Flood	15.5	64	4.78	73
1981	11.53	¼ way across from east shore	40 54 50	73 54 59	1	Flood	15.5	70	5.00	75
1982	11.55	¼ way across from east shore	40 54 50	73 54 59	20	Flood	15.5	66	4.87	74
1983	11.57	¼ way across from east shore	40 54 50	73 54 59	40	Flood	15.5	64	4.87	74
1984	P. M. 12.01	½ way across	40 54 50	73 55 15	1	Flood	15.5	72	5.04	75
1985	12.03	½ way across	40 54 50	73 55 15	20	Flood	15.5	66	4.90	74
1986	12.05	½ way across	40 54 50	73 55 15	35	Flood	15.5	66	4.90	74
1987	12.09	¾ way across from east shore	40 54 50	73 55 30	1	Flood	15.5	72	5.11	76
1988	12.11	¾ way across from east shore	40 54 50	73 55 30	10	Flood	15.5	68	5.00	75
1989	12.13	¾ way across from east shore	40 54 50	73 55 30	20	Flood	15.5	68	5.00	75
1990	12.17	500 feet off west shore	40 54 50	73 55 42	1	Flood	15.5	72	5.22	78
1991	12.19	500 feet off west shore	40 54 50	73 55 42	10	Flood	15.5	70	5.07	76
1992	12.21	500 feet off west shore	40 54 50	73 55 42	15	Flood	15.5	70	5.07	76
1993	2.00	500 feet off Mt. St. Vincent	40 54 50	73 54 49	1	Flood	15.5	64	4.78	73
1994	2.02	500 feet off Mt. St. Vincent	40 54 50	73 54 49	20	Flood	15.5	60	4.38	67
1995	2.04	500 feet off Mt. St. Vincent	40 54 50	73 54 49	40	Flood	15.5	60	4.38	67
1996	2.08	¼ way across from east shore	40 54 50	73 54 59	1	Flood	15.5	64	4.87	74
1997	2.10	¼ way across from east shore	40 54 50	73 54 59	20	Flood	15.5	60	4.44	68
1998	2.12	¼ way across from east shore	40 54 50	73 54 59	40	Flood	15.5	60	4.44	68
1999	2.16	½ way across	40 54 50	73 55 15	1	Flood	15.5	64	4.90	74
2000	2.18	½ way across	40 54 50	73 55 15	20	Flood	15.5	60	4.48	68
2001	2.20	½ way across	40 54 50	73 55 15	35	Flood	15.5	60	4.48	68
2002	2.24	¾ way across from east shore	40 54 50	73 55 30	1	Flood	15.5	64	5.00	76
2003	2.26	¾ way across from east shore	40 54 50	73 55 30	10	Flood	15.5	60	4.55	70
2004	2.28	¾ way across from east shore	40 54 50	73 55 30	20	Flood	15.5	60	4.55	70
2005	2.32	500 feet off west shore	40 54 50	73 55 42	1	Flood	15.5	68	5.07	77
2006	2.34	500 feet off west shore	40 54 50	73 55 42	10	Flood	15.5	62	4.64	71
2007	2.36	500 feet off west shore	40 54 50	73 55 42	15	Flood	15.5	60	4.64	71
2008	4.00	500 feet off Mt. St. Vincent	40 54 50	73 54 49	1	Ebb	16.0	64	4.78	73
2009	4.02	500 feet off Mt. St. Vincent	40 54 50	73 54 49	20	Ebb	16.0	60	4.78	74
2010	4.04	500 feet off Mt. St. Vincent	40 54 50	73 54 49	40	Ebb	16.0	60	4.94	76
2011	4.08	¼ way across from east shore	40 54 50	73 54 59	1	Ebb	16.0	64	4.87	74
2012	4.10	¼ way across from east shore	40 54 50	73 54 59	20	Ebb	16.0	60	4.87	75

TABLE XXVII—Continued

78—HUDSON RIVER, CROSS-SECTION AT MT. ST. VINCENT. OCTOBER 13, 1911—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
2013	4.12	¼ way across from east shore	40 54 50	73 54 59	40	Ebb	16.0	60	4.87	75
2014	4.16	½ way across	40 54 50	73 55 15	1	Ebb	16.0	64	5.04	76
2015	4.18	½ way across	40 54 50	73 55 15	20	Ebb	16.0	60	5.04	77
2016	4.20	½ way across	40 54 50	73 55 15	35	Ebb	16.0	60	5.04	77
2017	4.24	¾ way across from east shore	40 54 50	73 55 30	1	Ebb	16.0	64	5.11	77
2018	4.26	¾ way across from east shore	40 54 50	73 55 30	10	Ebb	16.0	60	5.00	77
2019	4.28	¾ way across from east shore	40 54 50	73 55 30	20	Ebb	16.0	60	5.00	77
2020	4.32	500 feet off west shore	40 54 50	73 55 42	1	Ebb	16.0	68	5.22	79
2021	4.34	500 feet off west shore	40 54 50	73 55 42	10	Ebb	16.0	60	5.07	78
2022	4.36	500 feet off west shore	40 54 50	73 55 42	15	Ebb	16.0	60	5.07	78
2023	5.15	500 feet off Mt. St. Vincent	40 54 50	73 54 49	1	Ebb	16.0	68	5.06	76
2024	5.17	500 feet off Mt. St. Vincent	50 44 50	73 54 49	20	Ebb	16.0	62	5.06	78
2025	5.19	500 feet off Mt. St. Vincent	40 54 50	73 54 49	40	Ebb	16.0	62	5.06	78
2026	5.23	¼ way across from east shore	40 54 50	73 54 59	1	Ebb	16.0	68	5.14	77
2027	5.25	¼ way across from east shore	40 54 50	73 54 59	20	Ebb	16.0	62	5.14	79
2028	5.27	¼ way across from east shore	40 54 50	73 54 59	4	Ebb	16.0	62	5.14	79
2029	5.30	½ way across	40 54 50	73 55 15	1	Ebb	16.0	68	5.18	78
2030	5.32	½ way across	40 54 50	73 55 15	20	Ebb	16.0	62	5.18	80
2031	5.34	½ way across	40 54 50	73 55 15	35	Ebb	16.0	62	5.18	80
2032	5.38	¾ way across from east shore	40 54 50	73 55 30	1	Ebb	16.0	70	5.26	79
2033	5.40	¾ way across from east shore	40 54 50	73 55 30	10	Ebb	16.0	62	5.26	81
2034	5.42	¾ way across from east shore	40 54 50	73 55 30	20	Ebb	16.0	62	5.26	81
2035	5.46	500 feet off west shore	40 54 50	73 55 42	1	Ebb	16.0	70	5.36	80
2036	5.48	500 feet off west shore	40 54 50	73 55 42	10	Ebb	16.0	62	5.36	83
2037	5.50	500 feet off west shore	40 54 50	73 55 42	15	Ebb	16.0	62	5.36	83

79—UPPER NEW YORK BAY, VICINITY OF ROBBIN'S REEF LIGHT. OCTOBER 16, 1911

Low water occurred at Governor's Island at 9.06 A. M. High water at 3.09 P. M. Ebb currents ended 11.45 A. M.

	A. M.									
2038	9.20	½ mile N. E. of Robbin's Reef light	40 39 44	74 03 29	1	Ebb	16.0	36	3.96	64
2039	9.22	½ mile N. E. of Robbin's Reef light	40 39 44	74 03 29	25	Ebb	16.5	32	3.96	65
2040	9.25	½ mile N. E. of Robbin's Reef light	40 39 44	74 03 29	45	Ebb	16.5	32	3.96	65
2041	9.35	½ mile E. S. E. of Robbin's Reef light	40 39 16	74 03 25	1	Ebb	16.0	38	3.98	64
2042	9.37	½ mile E. S. E. of Robbin's Reef light	40 39 16	74 03 25	20	Ebb	16.5	32	4.12	68
2043	9.40	½ mile E. S. E. of Robbin's Reef light	40 39 16	74 03 25	40	Ebb	16.5	32	4.12	68
2044	9.50	½ mile South of Robbin's Reef light	40 38 49	74 03 48	1	Ebb	16.0	36	4.03	65
2045	9.52	½ mile South of Robbin's Reef light	40 38 49	74 03 48	25	Ebb	16.5	32	4.03	67
2046	9.55	½ mile South of Robbin's Reef light	40 38 49	74 03 48	50	Ebb	16.5	32	4.03	67
2047	11.20	½ mile N. E. of Robbin's Reef light	40 39 44	74 03 29	1	End of Ebb	16.0	44	4.10	65
2048	11.22	½ mile N. E. of Robbin's Reef light	40 39 44	74 03 29	25	Flood	16.5	32	3.96	65
2049	11.25	½ mile N. E. of Robbin's Reef light	40 39 44	74 03 29	45	Flood	16.5	32	3.96	65
2050	11.35	½ mile E. S. E. of Robbin's Reef light	40 39 16	74 03 25	1	End of Ebb	16.0	44	4.12	66
2051	11.37	½ mile E. S. E. of Robbin's Reef light	40 39 16	74 03 25	20	Flood	16.5	32	3.98	66
2052	11.40	½ mile E. S. E. of Robbin's Reef light	40 39 16	74 03 25	40	Flood	16.5	32	3.98	66
2053	11.50	½ mile South of Robbin's Reef light	40 38 49	74 03 48	1	End of Ebb	16.0	44	4.17	66
2054	11.52	½ mile South of Robbin's Reef light	40 38 49	74 03 48	25	Flood	16.5	32	4.03	67
2055	11.55	½ mile South of Robbin's Reef light	40 38 49	74 03 48	50	Flood	16.5	32	4.03	67
	P. M.									
2056	1.20	½ mile N. E. of Robbin's Reef light	40 39 44	74 03 29	1	Flood	16.0	40	4.24	68
2057	1.22	½ mile N. E. of Robbin's Reef light	40 39 44	74 03 29	25	Flood	16.0	28	4.65	77

TABLE XXVII—Continued

79—UPPER NEW YORK BAY, VICINITY OF ROBBINS' REEF LIGHT. OCTOBER 16, 1911—Continued

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
2058	1.25	½ mile N. E. of Robbin's Reef light...	40 39 44	74 03 29	45	Flood	16.0	28	4.65	77
2059	1.35	½ mile E. S. E. of Robbin's Reef light	40 39 16	74 03 25	1	Flood	16.0	42	4.12	67
2060	1.37	½ mile E. S. E. of Robbin's Reef light	40 39 16	74 03 25	20	Flood	16.0	28	4.40	73
2061	1.40	½ mile E. S. E. of Robbin's Reef light	40 39 16	74 03 25	40	Flood	16.0	28	4.40	73
2062	1.50	½ mile South of Robbin's Reef light..	40 38 49	74 03 48	1	Flood	16.0	36	4.31	71
2063	1.52	½ mile South of Robbin's Reef light..	40 38 49	74 03 48	25	Flood	16.0	24	4.58	76
2064	1.55	½ mile South of Robbin's Reef light..	40 38 49	74 03 48	50	Flood	16.0	24	4.58	76
2065	3.20	½ mile N. E. of Robbin's Reef light...	40 39 44	74 03 29	1	Flood	16.0	32	4.65	77
2066	3.22	½ mile N. E. of Robbin's Reef light...	40 39 44	74 03 29	25	Flood	16.0	22	4.65	77
2067	3.25	½ mile N. E. of Robbin's Reef light..	40 39 44	74 03 29	45	Flood	16.0	22	4.65	77
2068	3.35	½ mile E. S. E. of Robbin's Reef light	40 39 16	74 03 25	1	Flood	16.0	32	4.55	75
2069	3.37	½ mile E. S. E. of Robbin's Reef light	40 39 16	74 03 25	20	Flood	16.0	22	4.55	76
2070	3.40	½ mile E. S. E. of Robbin's Reef light	40 39 16	74 02 25	40	Flood	16.0	22	4.55	76
2071	3.50	½ mile South of Robbin's Reef light..	40 38 49	74 03 48	1	Flood	16.0	28	4.58	76
2072	3.52	½ mile South of Robbin's Reef light..	40 38 49	74 03 48	25	Flood	16.0	20	4.58	76
2073	3.55	½ mile South of Robbin's Reef light..	40 38 49	74 03 48	50	Flood	16.0	20	4.58	76
2074	5.10	½ mile N. E. of Robbin's Reef light..	40 39 44	74 03 29	1	Flood	16.0	30	4.65	77
2075	5.12	½ mile N. E. of Robbin's Reef light..	40 39 44	74 03 29	25	Flood	16.0	20	4.65	79
2076	5.14	½ mile N. E. of Robbin's Reef light..	40 39 44	74 03 29	45	Flood	16.0	20	4.65	79
2077	5.18	½ mile E. S. E. of Robbin's Reef light	40 39 16	74 03 25	1	Flood	16.0	30	4.55	75
2078	5.20	½ mile E. S. E. of Robbin's Reef light	40 39 16	74 03 25	20	Flood	16.0	20	4.68	79
2079	5.22	½ mile E. S. E. of Robbin's Reef light	40 39 16	74 03 25	40	Flood	16.0	20	4.68	79
2080	5.26	½ mile south of Robbin's Reef light...	40 38 49	74 03 48	1	Flood	16.0	30	4.58	76
2081	5.28	½ mile south of Robbin's Reef light...	40 38 49	74 03 48	25	Flood	16.0	20	4.58	78
2082	5.30	½ mile south of Robbin's Reef light...	40 38 49	74 03 48	50	Flood	16.0	20	4.58	78

80—UPPER NEW YORK BAY, VICINITY OF ROBBIN'S REEF. OCTOBER 23, 1911

High water occurred at Governor's Island at 8.37 A. M. Low water at 3.10 P. M. Ebb currents began about 11.15 A. M.

	A. M.									
2083	9.30	500 feet east of buoy G. 2, 1 mile north of Robbin's Reef light............	40 40 12	74 03 10	1	Flood	16.0	62	4.78	75
2084	9.32	500 feet east of buoy G. 2, 1 mile north of Robbin's Reef light............	40 40 12	74 03 10	25	Flood	16.0	34	4.65	75
2085	9.35	500 feet east of buoy G. 2, 1 mile north of Robbin's Reef light............	40 40 12	74 03 10	50	Flood	16.0	32	4.65	76
2086	9.45	1 mile E. S. E. of Robbin's Reef light, line from light to 64th street, Brooklyn, and from Liberty Island to Fort Wadsworth....................	40 39 05	74 02 53	1	Flood	16.0	62	4.72	74
2087	9.47	1 mile E. S. E. of Robbin's Reef light, line from light to 64th street, Brooklyn, and from Liberty Island to Fort Wadsworth.....................	40 39 05	74 02 53	15	Flood	16.0	34	4.72	76
2088	9.50	1 mile E. S. E. of Robbin's Reef light, line from light to 64th street, Brooklyn, and from Liberty Island to Fort Wadsworth.....................	40 39 05	74 02 53	30	Flood	16.0	32	4.72	77
2089	10.00	1 mile S. S. E. of Robbin's Reef light, midway between 2 spar buoys off Tompkinsville, S. I...............	40 38 33	74 03 42	1	Flood	16.0	44	4.83	77
2090	10.02	1 mile S. S. E. of Robbin's Reef light, midway between 2 spar buoys off Tompkinsville, S. I...............	40 38 33	74 03 42	25	Flood	16.0	32	4.83	79

TABLE XXVII—Continued

80—UPPER NEW YORK BAY, VICINITY OF ROBBIN'S REEF. OCTOBER 23, 1911—Continued

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude ° ′ ″	Longitude ° ′ ″					C. C. per litre	Per cent. saturation
2091	10.05	1 mile S. S. E. of Robbin's Reef light, midway between 2 spar buoys off Tompkinsville, S. I.	40 38 33	74 03 42	50	Flood	16.0	30	4.83	79
2092	10.15	¼ mile south of east of Robbin's Reef light, ¼ mile northeast of Robbin's Reef bell buoy	40 39 26	74 03 37	1	Flood	16.0	46	4.92	78
2093	10.17	¼ mile south of east of Robbin's Reef light, ¼ mile northeast of Robbin's Reef bell buoy	40 39 26	74 03 37	30	Flood	16.0	32	4.92	81
2094	10.20	¼ mile south of east of Robbin's Reef light, ¼ mile northeast of Robbin's Reef bell buoy	40 39 26	74 03 37	50	Flood	16.0	32	4.92	81
2095	10.44	Narrows, midway between forts	40 36 25	74 02 48	1	Flood	16.0	42	5.07	81
2096	10.47	Narrows, midway between forts	40 36 25	74 02 48	40	Flood	16.0	32	5.07	83
2097	10.50	Narrows, midway between forts	40 36 25	74 02 48	80	Flood	16.0	30	5.07	83
2098	P. M. 12.30	500 feet east of buoy G. 2	40 40 12	74 03 10	1	Ebb	16.0	52	4.10	65
2099	12.32	500 feet east of buoy G. 2	40 40 12	74 03 10	25	Ebb	16.0	38	4.10	66
2100	12.35	500 feet east of buoy G. 2	40 40 12	74 03 10	50	Ebb	16.0	38	4.10	66
2101	12.45	1 mile E. S. S. of Robbin's Reef	40 39 05	74 02 53	1	Ebb	16.0	54	4.31	68
2102	12.47	1 mile E. S. S. of Robbin's Reef	40 39 05	74 02 53	15	Ebb	16.0	36	4.58	74
2103	12.50	1 mile E. S. S. of Robbin's Reef	40 39 05	74 02 53	30	Ebb	16.0	36	4.58	74
2104	1.00	1 mile S. S. E. of Robbin's Reef	40 38 33	74 03 42	1	Ebb	16.0	54	4.68	74
2105	1.02	1 mile S. S. E. of Robbin's Reef	40 38 33	74 03 42	25	Ebb	16.0	46	4.55	72
2106	1.05	1 mile S. S. E. of Robbin's Reef	40 38 33	74 03 42	50	Ebb	16.0	46	4.55	72
2107	1.15	¼ mile south of east of Robbin's Reef	40 39 26	74 03 37	1	Ebb	16.0	66	4.78	75
2108	1.17	¼ mile south of east of Robbin's Reef	40 39 26	74 03 37	30	Ebb	16.0	40	4.78	76
2109	1.20	¼ mile south of east of Robbin's Reef	40 39 26	74 03 37	50	Ebb	16.0	40	4.78	76
2110	1.45	Narrows, midway between forts	40 36 25	74 02 48	1	Ebb	16.0	54	4.63	73
2111	1.47	Narrows, midway between forts	40 36 25	74 02 48	40	Ebb	16.0	42	4.63	74
2112	1.50	Narrows, midway between forts	40 36 25	74 02 48	80	Ebb	16.0	42	4.63	74
2113	3.30	500 feet east of buoy G. 2	40 40 12	74 03 10	1	Ebb	16.0	66	4.51	69
2114	3.32	500 feet east of buoy G. 2	40 40 12	74 03 10	25	Ebb	16.0	52	4.38	70
2115	3.35	500 feet east of buoy G. 2	40 40 12	74 03 10	50	Ebb	16.0	52	4.38	70
2116	3.45	1 mile E. S. E. of Robbin's Reef	40 39 05	74 02 53	1	Ebb	16.0	74	4.58	69
2117	3.47	1 mile E. S. E. of Robbin's Reef	40 39 05	74 02 53	15	Ebb	16.0	58	4.44	69
2118	3.50	1 mile E. S. E. of Robbin's Reef	40 39 05	74 02 53	30	Ebb	16.0	58	4.44	70
2119	4.00	1 mile S. S. E of Robbin's Reef	40 38 33	74 03 42	1	Ebb	16.0	68	4.40	70
2120	4.02	1 mile S. S. E. of Robbin's Reef	40 38 33	74 03 42	25	Ebb	16.0	52	4.26	68
2121	4.05	1 mile S. S. E. of Robbin's Reef	40 38 33	74 03 42	50	Ebb	16.0	52	4.26	68
2122	4.15	¼ mile south of east of Robbin's Reef	40 39 26	74 03 37	1	Ebb	16.0	64	4.34	67
2123	4.17	¼ mile south of east of Robbin's Reef	40 39 26	74 03 37	30	Ebb	16.0	52	4.34	69
2124	4.20	¼ mile south of east of Robbin's Reef	40 39 26	74 03 37	50	Ebb	16.0	50	4.34	69
2125	4.45	Narrows, midway between forts	40 36 25	74 02 48	1	Ebb	16.0	64	4.92	76
2126	4.47	Narrows, midway between forts	40 36 25	74 02 48	40	Ebb	16.0	50	4.92	78
2127	4.50	Narrows, midway between forts	40 36 25	74 02 48	80	Ebb	16.0	50	4.92	78

81—UPPER NEW YORK BAY, VICINITY OF ROBBIN'S REEF. OCTOBER 24, 1911

High water occurred at Governor's Island at 9.15 A. M. Low water at 3.55 P. M. Ebb currents began about 11.45 A. M

2128	A. M. 9.45	¼ mile south of east of Robbin's Reef light	40 39 26	74 03 37	1	Flood	15.5	52	4.65	72
2129	9.48	¼ mile south of east of Robbin's Reef light	40 39 26	74 03 37	30	Flood	15.5	44	4.38	68
2130	9.51	¼ mile south of east of Robbin's Reef light	40 39 26	74 03 37	50	Flood	15.5	44	4.38	68

TABLE XXVII—Continued

81—UPPER NEW YORK BAY, VICINITY OF ROBBIN'S REEF. OCTOBER 24, 1911—Continued

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
2131	10.00	¼ mile southeast of Robbin's Reef light	40 39 19	74 03 42	1	Flood	15.5	52	4.72	73
2132	10.03	¼ mile southeast of Robbin's Reef light	40 39 19	74 03 42	20	Flood	15.5	44	4.44	69
2133	10.06	¼ mile southeast of Robbin's Reef light	40 39 19	74 03 42	40	Flood	15.5	42	4.44	70
2134	10.15	¼ mile south of Robbin's Reef light	40 39 13	74 03 54	1	Flood	15.5	46	4.83	75
2135	10.18	¼ mile south of Robbin's Reef light	40 39 13	74 03 54	10	Flood	15.5	42	4.55	72
2136	10.21	¼ mile south of Robbin's Reef light	40 39 13	74 03 54	20	Flood	15.5	38	4.55	72
2137	10.30	Near spar buoy A (nearest Baxter Ledge), off Tompkinsville	40 38 44	74 03 42	1	Flood	15.5	52	4.92	76
2138	10.33	Near spar buoy A (nearest Baxter Ledge), off Tompkinsville	40 38 44	74 03 42	25	Flood	15.5	36	4.92	79
2139	10.36	Near spar buoy A (nearest Baxter Ledge), off Tompkinsville	40 38 44	74 03 42	50	Flood	15.5	34	4.92	79
2140	11.00	Narrows, midway between forts	40 36 25	74 02 48	1	Flood	15.5	42	5.22	83
2141	11.03	Narrows, midway between forts	40 36 25	74 02 48	40	Flood	15.5	30	5.07	82
2142	11.06	Narrows, midway between forts	40 36 25	74 02 48	80	Flood	15.5	30	5.07	82
	P. M.									
2143	12.45	¼ mile south of east of Robbin's Reef	40 39 26	74 03 37	1	Ebb	16.0	56	4.94	77
2144	12.48	¼ mile south of east of Robbin's Reef	40 39 26	74 03 37	30	Ebb	16.0	40	4.94	79
2145	12.51	¼ mile south of east of Robbin's Reef	40 39 26	74 03 37	60	Ebb	16.0	40	4.94	79
2146	1.00	¼ mile southeast of Robbin's Reef	40 39 19	74 03 42	1	Ebb	16.0	56	5.00	78
2147	1.03	¼ mile southeast of Robbin's Reef	40 39 19	74 03 42	20	Ebb	16.0	40	5.00	80
2148	1.06	¼ mile southeast of Robbin's Reef	40 39 19	74 03 42	40	Ebb	16.0	40	5.00	80
2149	1.15	¼ mile south of Robbin's Reef	40 39 13	74 03 54	1	Ebb	16.0	56	5.11	80
2150	1.18	¼ mile south of Robbin's Reef	40 39 13	74 03 54	10	Ebb	16.0	46	5.11	82
2151	1.21	¼ mile south of Robbin's Reef	40 39 13	73 03 54	20	Ebb	16.0	42	5.11	82
2152	1.30	Near spar buoy A, nearest Baxter ledge	40 38 44	74 03 42	1	Ebb	16.0	54	5.22	82
2153	1.33	Near spar buoy A, nearest Baxter ledge	40 38 44	74 03 42	25	Ebb	16.0	44	5.22	83
2154	1.36	Near spar buoy A, nearest Baxter ledge	40 38 44	74 03 42	50	Ebb	16.0	42	5.22	83
2155	2.00	Narrows, midway between forts	40 36 25	74 02 48	1	Ebb	16.0	54	5.22	82
2156	2.03	Narrows, midway between forts	40 36 25	74 02 48	40	Ebb	16.0	40	5.22	83
2157	2.06	Narrows, midway between forts	40 36 25	74 02 48	80	Ebb	16.0	40	5.22	83
2158	3.45	¼ mile south of east of Robbin's Reef	40 39 26	74 03 37	1	Ebb	15.5	64	5.06	77
2159	3.47	¼ mile south of east of Robbin's Reef	40 39 26	74 03 37	30	Ebb	15.5	52	5.06	78
2160	3.50	¼ mile south of east of Robbin's Reef	40 39 26	74 03 37	60	Ebb	15.5	52	5.06	78
2161	4.00	¼ mile southeast of Robbin's Reef	40 39 19	74 03 42	1	Ebb	15.5	64	5.14	78
2162	4.02	¼ mile southeast of Robbin's Reef	40 39 19	74 03 42	20	Ebb	15.5	52	5.14	80
2163	4.05	¼ mile southeast of Robbin's Reef	40 39 19	74 03 42	40	Ebb	15.5	52	5.14	80
2164	4.15	¼ mile south of Robbin's Reef	40 39 13	74 03 54	1	Ebb	15.5	68	5.26	79
2165	4.17	¼ mile south of Robbin's Reef	40 39 13	74 03 54	10	Ebb	15.5	52	5.26	81
2166	4.20	¼ mile south of Robbin's Reef	40 39 13	74 03 54	20	Ebb	15.5	52	5.26	81
2167	4.30	Near spar buoy A, nearest Baxter ledge	40 38 44	74 03 42	1	Ebb	15.5	68	5.36	80
2168	4.32	Near spar buoy A, nearest Baxter ledge	40 38 44	74 03 42	25	Ebb	15.5	52	5.36	83
2169	4.35	Near spar buoy A, nearest Baxter ledge	40 38 44	74 03 42	50	Ebb	15.5	52	5.36	83
2170	4.50	Narrows, midway between forts	40 36 25	74 02 48	1	Ebb	15.5	60	5.52	84
2171	4.52	Narrows, midway between forts	40 36 25	74 02 48	40	Ebb	15.5	52	5.52	86
2172	4.55	Narrows, midway between forts	40 36 25	74 02 48	80	Ebb	15.5	52	5.52	86

TABLE XXVII—Continued

82—EAST RIVER, CROSS-SECTION, THROGS NECK TO WILLET'S POINT. OCTOBER 25, 1911

High water at Governor's Island at 9.52 A. M. Low water at Hell Gate at 5.30 A. M.
High water at Hell Gate at 11.42 A. M. Low water at 6.20 P. M.

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
2173	7.30	¼ way across from Throgs Neck	40 48 08	73 47 42	1	Ebb	15.0	26	4.38	71
2174	7.32	¼ way across from Throgs Neck	40 48 08	73 47 42	30	Ebb	14.5	26	4.94	79
2175	7.35	¼ way across from Throgs Neck	40 48 08	73 47 42	60	Ebb	14.5	26	4.94	79
2176	7.42	½ way across	40 48 00	74 47 13	1	Ebb	15.0	26	4.44	72
2177	7.44	½ way across	40 48 00	73 47 13	40	Ebb	14.5	26	5.00	80
2178	7.47	½ way across	40 48 00	73 47 13	80	Ebb	14.5	26	5.00	80
2179	7.55	¾ way across from Throgs Neck	40 47 54	73 47 05	1	Ebb	15.0	26	4.48	73
2180	7.57	¾ way across from Throgs Neck	40 47 54	73 47 05	35	Ebb	14.5	26	5.04	80
2181	8.00	¾ way across from Throgs Neck	40 47 54	73 47 05	70	Ebb	14.5	26	5.04	80
2182	9.30	¼ way across from Throgs Neck	40 47 54	73 47 05	1	Flood	15.0	24	4.94	79
2183	9.32	¼ way across from Throgs Neck	40 47 54	73 47 05	30	Flood	15.0	22	5.33	87
2184	9.35	¼ way across from Throgs Neck	40 47 54	73 47 05	60	Flood	15.0	22	5.33	87
2185	9.42	½ way across	40 47 54	73 47 05	1	Flood	15.0	24	4.87	78
2186	9.44	½ way across	40 47 54	73 47 05	40	Flood	15.0	22	5.42	89
2187	9.47	½ way across	40 47 54	73 47 05	80	Flood	15.0	22	5.42	89
2188	9.55	¾ way across from Throgs Neck	40 47 54	73 47 05	1	Flood	15.0	24	4.90	78
2189	9.57	¾ way across from Throgs Neck	40 47 54	73 47 05	35	Flood	15.0	24	5.46	90
2190	10.00	¾ way across from Throgs Neck	40 47 54	73 47 05	70	Flood	15.0	24	5.46	90
2191	11.30	¼ way across from Throgs Neck	40 47 54	73 47 05	1	Flood	16.0	24	5.33	88
2192	11.32	¼ way across from Throgs Neck	40 47 54	73 47 05	30	Flood	16.0	24	5.33	88
2193	11.35	¼ way across from Throgs Neck	40 47 54	73 47 05	60	Flood	16.0	24	5.33	88
2194	11.42	½ way across	40 47 54	73 47 05	1	Flood	16.0	24	5.42	89
2195	11.44	½ way across	40 47 54	73 47 05	40	Flood	16.0	24	5.42	89
2196	11.47	½ way across	40 47 54	73 47 05	80	Flood	16.0	24	5.42	89
2197	11.55	¾ way across from Throgs Neck	40 47 54	73 47 05	1	Flood	16.0	24	5.46	90
2198	11.57	¾ way across from Throgs Neck	40 47 54	73 47 05	35	Flood	16.0	24	5.46	90
2199	12.00	¾ way across from Throgs Neck	40 47 54	73 47 05	70	Flood	16.0	24	5.46	90
	P. M.									
2200	1.30	¼ way across from Throgs Neck	40 47 54	73 47 05	1	Ebb	15.5	24	5.33	87
2201	1.32	¼ way across from Throgs Neck	40 47 54	73 47 05	30	Flood	15.0	24	5.60	92
2202	1.35	¼ way across from Throgs Neck	40 47 54	73 47 05	60	Flood	15.0	24	5.60	92
2203	1.42	½ way across	40 47 54	73 47 05	1	Flood	15.5	24	5.42	89
2204	1.44	½ way across	40 47 54	73 47 05	40	Flood	15.0	24	5.69	93
2205	1.47	½ way across	40 47 54	73 47 05	80	Flood	15.0	24	5.69	93
2206	1.55	¾ way across from Throgs Neck	40 47 54	73 47 05	1	Flood	15.5	24	5.46	90
2207	1.57	¾ way across from Throgs Neck	40 47 54	73 47 05	35	Flood	15.0	24	5.74	94
2208	2.00	¾ way across from Throgs Neck	40 47 54	73 47 05	70	Flood	15.0	24	5.74	94
2209	3.30	¼ way across from Throgs Neck	40 47 54	73 47 05	1	Ebb	15.5	24	5.19	85
2210	3.32	¼ way across from Throgs Neck	40 47 54	73 47 05	30	Ebb	15.5	24	5.19	85
2211	3.35	¼ way across from Throgs Neck	40 47 54	73 47 05	60	Ebb	15.5	24	5.19	85
2212	3.42	½ way across	40 47 54	73 47 05	1	Ebb	15.5	24	5.28	87
2213	3.45	½ way across	40 47 54	73 47 05	40	Ebb	15.5	24	5.28	87
2214	3.47	½ way across	40 47 54	73 47 05	80	Ebb	15.5	24	5.28	87
2215	3.55	¾ way across from Throgs Neck	40 47 54	73 47 05	1	Ebb	15.5	24	5.32	87
2216	3.57	¾ way across from Throgs Neck	40 47 54	73 47 05	35	Ebb	15.5	24	5.32	87
2217	4.00	¾ way across from Throgs Neck	40 47 54	73 47 05	70	Ebb	15.5	24	5.32	87
2218	5.00	¼ way across from Throgs Neck	40 47 54	73 47 05	1	Ebb	15.5	24	4.65	76
2219	5.02	¼ way across from Throgs Neck	40 47 54	73 47 05	30	Ebb	15.5	24	5.19	85
2220	5.05	¼ way across from Throgs Neck	40 47 54	75 47 05	60	Ebb	15.5	24	5.19	85
2221	5.12	½ way across	40 47 54	73 47 05	1	Ebb	15.5	24	4.72	77
2222	5.14	½ way across	40 47 54	73 47 05	40	Ebb	15.5	24	5.28	87
2223	5.17	½ way across	40 47 54	73 47 05	80	Ebb	15.5	24	5.28	87
2224	5.25	¾ way across from Throgs Neck	40 47 54	73 47 05	1	Ebb	15.5	24	4.76	78
2225	5.27	¾ way across from Throgs Neck	40 47 54	73 47 05	35	Ebb	15.5	24	5.32	87
2226	5.30	¾ way across from Throgs Neck	40 47 54	73 47 05	70	Ebb	15.5	24	4.32	87

TABLE XXVII—Continued

83—UPPER NEW YORK BAY, COURSE FROM MOUTH OF HUDSON RIVER TO NARROWS. OCTOBER 26, 1911

High water at Governor's Island at 10.32 A. M. Low water at 5.25 P. M.

Sample No.	Hour A. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
2227	10.20	Hudson river, midstream off Pier A...	40 42 19	74 01 34	1	Flood	15.5	74	5.19	76
2228	10.22	Hudson river, midstream off Pier A...	40 42 19	74 01 34	20	Flood	15.0	52	4.78	74
2229	10.25	Hudson river, midstream off Pier A...	40 42 19	74 01 34	40	Flood	15.0	52	4.78	74
2230	10.40	200 feet east of red spar buoy 2, off Ellis Island......................	40 41 51	74 02 03	1	Flood	15.5	70	5.28	79
2231	10.42	200 feet east of red spar buoy 2, off Ellis Island......................	40 41 51	74 02 03	15	Flood	15.0	52	5.28	81
2232	10.45	200 feet east of red spar buoy 2, off Ellis Island......................	40 41 51	74 02 03	25	Flood	15.0	46	5.28	82
2233	11.00	500 feet east of gas buoy 2, off Liberty Island..........................	40 41 10	74 02 30	1	Flood	15.5	68	5.11	76
2234	11.02	500 feet east of gas buoy 2, off Liberty Island..........................	40 41 10	74 02 30	20	Flood	15.0	54	5.11	77
2235	11.05	500 feet east of gas buoy 2, off Liberty Island..........................	40 41 10	74 02 30	40	Flood	15.0	54	5.11	77
2236	11.20	200 feet east of buoy G. 2, off entrance to P. R.R. ferry..................	40 40 12	74 03 13	1	Flood	15.5	64	5.51	84
2237	11.22	200 feet east of buoy G. 2, off entrance to P. R.R. ferry..................	40 40 12	74 03 13	15	Flood	15.0	48	5.22	80
2238	11.25	200 feet eastof buoy G. 2, off entrance to P. R.R. ferry..................	40 40 12	74 03 13	30	Flood	15.0	48	5.22	80
2239	11.40	¼ mile south of east of Robbin's Reef light..........................	40 39 26	74 03 37	1	Flood	15.5	68	5.19	77
2240	11.42	¼ mile south of east of Robbin's Reef light..........................	40 39 26	74 03 37	30	Flood	15.0	44	5.19	80
2241	11.45	¼ mile south of east of Robbin's Reef light..........................	40 39 26	74 03 37	60	Flood	15.0	44	5.19	80
2242	12.00	200 feet west of bell buoy 12½, off Owl Head..........................	40 38 22	74 03 17	1	Flood	15.5	60	5.00	77
2243	P. M. 12.02	200 feet west of bell buoy 12½, off Owl Head..........................	40 38 22	74 03 17	15	Flood	15.0	40	5.00	78
2244	12.05	200 feet west of bell buoy 12½, off Owl Head..........................	40 38 22	74 03 17	30	Flood	15.0	40	5.00	78
2245	12.25	Narrows, midway between forts......	40 36 25	74 02 28	1	Flood	15.5	48	5.26	81
2246	12.27	Narrows, midway between forts......	40 36 25	74 02 48	40	Flood	15.0	36	5.26	83
2247	12.30	Narrows, midway between forts......	40 36 25	74 02 48	80	Flood	15.0	36	5.26	83
2248	3.30	Narrows, midway between forts......	40 36 25	74 02 48	1	Ebb	16.0	64	5.11	77
2249	3.32	Narrows, midway between forts......	40 36 25	74 02 48	40	Ebb	16.0	46	5.11	81
2250	3.35	Narrows, midway between forts......	40 36 25	74 02 48	80	Ebb	16.0	46	5.11	81
2251	4.00	200 feet west of bell buoy 12½, off Owl Head..........................	40 36 25	74 02 48	1	Ebb	16.0	64	4.98	75
2252	4.02	200 feet west of bell buoy 12½, off Owl Head..........................	40 36 25	74 02 48	15	Ebb	16.0	44	5.28	84
2253	4.05	200 feet west of bell buoy 12½, off Owl Head..........................	40 36 25	74 02 48	30	Ebb	16.0	44	5.28	84
2254	4.15	¼ mile south of east of Robbin's Reef light..........................	40 39 26	74 03 37	1	Ebb	16.0	64	4.78	73
2255	4.17	¼ mile south of east of Robbin's Reef light..........................	40 39 26	74 03 37	30	Ebb	16.0	50	4.78	75
2256	4.20	¼ mile south of east of Robbin's Reef light..........................	40 39 26	74 03 37	60	Ebb	16.0	50	4.78	75
2257	4.30	200 feet east of buoy G. 2...........	40 39 26	74 03 37	1	Ebb	16.0	60	4.92	76
2258	4.32	200 feet east of buoy G. 2...........	40 39 26	74 03 37	15	Ebb	16.0	52	4.92	77
2259	4.35	200 feet of east buoy G. 2...........	40 39 26	74 03 37	30	Ebb	16.0	52	4.92	77
2260	4.45	500 feet east of gas buoy 2, off Liberty Island..........................	40 39 26	74 03 37	1	Ebb	16.0	70	5.39	81

TABLE XXVII—Continued

83—UPPER NEW YORK BAY, COURSE FROM MOUTH OF HUDSON RIVER TO NARROWS.
OCTOBER 26, 1911—Continued.

Sample No.	Hour P. M.	Location of Samples: Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen: C. C. per litre	Oxygen: Per cent. saturation
			° ′ ″	° ′ ″						
2261	4.47	500 feet east of gas buoy 2, off Liberty Island	40 39 26	74 03 37	20	Ebb	16.0	66	5.11	80
2262	4.50	500 feet east of gas buoy 2, off Liberty Island	40 39 26	74 03 37	40	Ebb	16.0	66	5.11	80
2263	5.00	200 feet east of Red spar buoy 2, off Ellis Island	40 41 51	74 02 03	1	Ebb	16.0	76	5.28	79
2264	5.02	200 feet east of Red spar buoy 2, off Ellis Island	40 41 51	74 02 03	15	Ebb	16.0	68	5.00	75
2265	5.04	200 feet of east Red spar buoy 2, off Ellis Island	40 41 51	74 02 03	25	Ebb	16.0	56	5.00	78
2266	5.08	Hudson river, midstream off Pier A	40 42 19	74 01 34	1	Ebb	16.0	78	5.19	76
2267	5.10	Hudson river, midstream off Pier A	40 42 19	74 01 34	20	Ebb	16.0	56	4.94	77
2268	5.12	Hudson river, midstream off Pier A	40 42 19	74 01 34	40	Ebb	16.0	54	4.94	77

84—HUDSON RIVER. OCTOBER 27, 1911

High water at Governor's Island at 11.10 A. M. Low water at 6.15 P. M.

Sample No.	Hour	Location of Samples: Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen: C. C. per litre	Oxygen: Per cent. saturation
	A. M.									
2269	11.15	Hudson river, midstream off Pier A	40 42 19	70 01 34	1	Flood	15.0	76	5.42	81
2270	11.17	Hudson river, midstream off Pier A	40 42 19	70 01 34	20	Flood	15.0	40	5.28	84
2271	11.20	Hudson river, midstream off Pier A	40 42 19	70 01 34	40	Flood	15.0	36	5.28	85
	P. M.									
2272	2.30	Hudson river, midstream off Spuyten Duyvil	40 52 50	73 56 04	1	Flood	15.0	88	5.83	82
2273	2.32	Hudson river, midstream off Spuyten Duyvil	40 52 50	73 56 04	15	Flood	15.0	68	5.00	74
2274	2.35	Hudson river, midstream off Spuyten Duyvil	40 52 50	73 56 04	30	Flood	15.0	60	5.00	75

85—SLIPS, ETC. OCTOBER 30, 1911

High water occurred at Governor's Island at 1.38 P. M. Low water at 7.52 A. M. High water occurred at Hell Gate at 3.28 P.M

Sample No.	Hour	Location of Samples: Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen: C. C. per litre	Oxygen: Per cent. saturation
	A. M.									
2275	10.30	1000 feet off Morse Dry Docks between 55th and 57th streets, Brooklyn	40 39 05	74 01 53	1	Flood	15.0	50	4.17	64
2276	10.35	1000 feet off Morse Dry Docks between 55th and 57th streets, Brooklyn	40 39 05	74 01 53	30	Flood	15.0	50	4.17	64
2277	11.30	2d slip east of Degraw street, middle of slip	40 41 16	74 00 24	1	Flood	15.0	48	3.06	47
2278	11.35	2d slip east of Degraw street, middle of slip	40 41 16	74 00 24	20	Flood	15.0	46	3.33	52
	P. M.									
2279	1.00	Wallabout Canal, near Market	40 42 12	73 58 08	1	Flood	15.0	50	1.67	30
2280	1.05	Wallabout Canal, near Market	40 42 12	73 58 08	20	Flood	15.0	50	1.67	30
2281	1.45	Slip north of foot of East 24th street, New York, middle of slip	40 44 09	73 58 27	1	Flood	15.0	46	3.06	47
2282	1.50	Slip north of foot of East 24th street, New York, middle of slip	40 44 09	73 58 27	20	Flood	15.0	46	3.06	47
2283	2.30	Slip foot Broadway, Astoria, outer end of slip	40 46 07	73 56 16	1	Flood	15.0	42	2.78	43
2284	2.35	Slip foot Broadway, Astoria, outer end of slip	40 46 07	73 56 16	10	Flood	15.0	42	2.78	43
2285	3.20	Slip, foot East 109th street, Harlem river	40 47 24	73 56 11	1	Flood	15.0	40	2.50	39
2286	3.25	Slip, foot East 109th street, Harlem river	40 47 24	73 56 11	20	Flood	15.0	40	2.50	39

TABLE XXVII—Continued

86—THE NARROWS, DEEP HOLE OUTSIDE FORT LAFAYETTE. NOVEMBER 1, 1911

Low water occurred at Governor's Island at 9.52 A. M. High water at 3.30 P. M.

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
2287	1.00	The Narrows, line between red spar buoy 12¼ and black can buoy 13, ⅓ way across from buoy 12¼, south of Fort Hamilton....................	40 35 57	74 02 15	1	Ebb	14.5	42	5.00	78
2288	1.05	The Narrows, line between red spar buoy 12¼ and black can buoy 13, ⅓ way across from buoy 12¼, south of Fort Hamilton....................	40 35 57	74 02 15	60	Flood	15.0	30	5.42	87
2289	1.10	The Narrows, line between red spar buoy 12¼ and black can buoy 13, ⅓ way across from buoy 12¼, south of Fort Hamilton....................	40 35 57	74 02 15	120	Flood	15.0	28	5.42	87
2290	3.30	The Narrows, deep hole, same as above	40 35 57	74 02 15	1	Flood	14.5	34	5.42	85
2291	3.35	The Narrows, deep hole, same as above	40 35 57	74 02 15	60	Flood	15.0	28	5.56	90
2292	3.40	The Narrows, deep hole, same as above	40 35 57	74 02 15	120	Flood	15.0	26	5.56	90

87—HARLEM RIVER, SLIP FOOT OF EAST 109th STREET. NOVEMBER 2, 1911

Low water occurred at Governor's Island at 10.42 A. M. High water at 4.25 P. M.
Low water occurred at Hell Gate at 12.40 P. M. High water at 6.15 P. M.

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
	P. M.									
2293	12.30	Slip foot of East 109th street.........	40 47 24	73 56 11	1	Ebb	14.0	32	2.22	35
2294	12.35	Slip foot of East 109th street.........	40 47 24	73 56 11	15	Ebb	14.5	32	2.22	35
2295	1.30	Slip foot of East 109th street.........	40 47 24	73 56 11	1	Flood	14.0	30	2.22	35
2296	1.35	Slip foot of East 109th street.........	40 47 24	73 56 11	15	Flood	14.5	30	2.22	35
2297	2.30	Slip foot of East 109th street.........	40 47 24	73 56 11	1	Flood	14.0	30	2.22	35
2298	2.35	Slip foot of East 109th street.........	40 47 24	73 56 11	15	Flood	14.0	30	2.22	35
2299	4.00	Slip foot of East 109th street.........	40 47 24	73 56 11	1	Flood	13.5	30	2.22	34
2300	4.05	Slip foot of East 109th street.........	40 47 24	73 56 11	15	Flood	14.0	30	2.22	35

88—EAST RIVER, DEEP HOLE OFF EAST 134th STREET, AND SLIP AT EAST 14th STREET. NOVEMBER 3, 1911

Low water occurred at Governor's Island at 11.30 A. M. High water at 5.12 P. M.
Low water occurred at Hell Gate at 1.10 P. M. High water at 7.02 P. M.

Sample No.	Hour	Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	C. C. per litre	Per cent. saturation
	A. M.									
2301	9.30	East river, 200 feet off East 134th street ferry, deep hole.............	40 47 56	73 54 30	1	Ebb	13.0	24	5.11	79
2302	9.35	East river, 200 feet off East 134th street ferry, deep hole.............	40 47 56	73 54 30	40	Ebb	12.0	22	5.39	84
2303	9.40	East river, 200 feet off East 134th street ferry, deep hole.............	40 47 56	73 54 30	75	Ebb	12.0	22	5.39	84
2304	11.00	Slip between foot of East 13th and 14th streets, New York, inner end.......	40 43 36	73 58 24	1	Ebb	13.0	36	3.12	47
2305	11.05	Slip between foot of East 13th and 14th streets, New York, inner end.......	40 43 36	73 58 24	15	Ebb	13.0	36	3.12	47

TABLE XXVII—Continued

89—EAST RIVER AND LONG ISLAND SOUND, DEEP HOLES AT OLD FERRY POINT AND STEPPING STONES. NOVEMBER 8, 1911

High water occurred at Governor's Island at 8.45 A. M. Low water at 3.25 P. M.
High water occurred at Hell Gate at 10.35 A. M. Low water at 5.05 P. M.

Sample No.	Hour P. M.	Location of Samples: Approximate	Latitude	Longitude	Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen: C. C. per litre	Oxygen: Per cent. saturation
			° ′ ″	° ′ ″						
2306	2.00	East river, deep hole ½ mile east of Old Ferry Point	40 48 18	73 49 20	1	Ebb	12.0	24	5.46	84
2307	2.05	East river, deep hole ½ mile east of Old Ferry Point	40 48 18	73 49 20	50	Ebb	13.0	22	5.46	85
2308	2.10	East river, deep hole ½ mile east of Old Ferry Point	40 48 18	73 49 20	110	Ebb	13.0	22	5.46	85
2309	3.00	Long Island Sound, ½ mile west of Stepping Stones light	40 49 33	73 46 59	1	Ebb	12.0	22	5.83	90
2310	3.05	Long Island Sound, ½ mile west of Stepping Stones light	40 49 33	73 46 59	50	Ebb	13.0	22	5.83	91
2311	3.10	Long Island Sound, ½ mile west of Stepping Stones light	40 49 33	73 46 59	100	Ebb	13.0	22	5.83	91

90—BUTTERMILK CHANNEL SLIPS, DE GRAW STREET AND VICINITY. NOVEMBER 9, 1911

High water occurred at Governor's Island at 9.30 A. M. Low water at 4.20 P. M.

	A. M.									
2312	10.30	Slip two blocks east of De Graw street, ½ way up slip	40 41 16	74 00 23	1	Flood	13.0	30	2.78	42
2313	10.33	Slip two blocks east of De Graw street, ½ way up slip	40 41 16	74 00 23	15	Flood	13.0	30	2.78	42
2314	11.30	Slip at DeGraw street, Brooklyn, outer end	40 41 14	74 00 29	1	Ebb	13.0	30	2.78	42
2315	11.33	Slip at DeGraw street, Brooklyn, outer end	40 41 14	74 00 29	15	Ebb	13.0	30	2.78	42

91—HUDSON RIVER, FORT WASHINGTON POINT. NOVEMBER 10, 1911

High water occured at Governor's Island at 10.25 A.M. Low water at 5.15 P.M. High water at Hell Gate at 12.50 P.M.

	P. M.									
2316	12.10	500 feet off Fort Washington Point, to southwest	40 50 55	73 56 57	1	Flood	11.5	56	5.00	71
2317	12.15	500 feet off Fort Washington Point, to southwest	40 50 55	73 56 57	75	Flood	12.0	48	5.00	71
2318	12.25	500 feet off Fort Washington Point, to southwest	40 50 55	73 56 57	150	Flood	12.0	48	5.00	71

92—NEWTOWN CREEK. NOVEMBER 13, 1911.

Low water occurred at Governor's Island at 7.45 A. M. High water at 1.38 P. M.
Low water occurred at Hell Gate at 9.25 A. M. High water at 3.26 P. M.

	A. M.									
2319	11.00	Mouth of creek	40 44 13	73 57 43	1	Flood	11.0	32	3.41	50
2320	11.05	Mouth of creek	40 44 13	73 57 43	20	Flood	11.0	32	3.41	50
2321	11.30	Vernon avenue bridge, first bridge	40 44 21	73 57 20	1	Flood	11.0	32	0.84	12
2322	11.35	Vernon avenue bridge, first bridge	40 44 21	73 57 20	20	Flood	11.0	32	0.84	12
	P. M.									
2323	12.00	Greenpoint Avenue Bridge, second bridge	40 44 00	73 56 30	1	Flood	11.0	32	0.29	4
2324	12.05	Greenpoint Avenue Bridge, second bridge	40 44 00	73 56 30	20	Flood	11.0	32	0.29	4
2325	12.30	Meeker Avenue Bridge, third bridge	40 43 40	73 55 00	1	Flood	11.0	32	0.00	0
2326	12.35	Meeker Avenue Bridge, third bridge	40 43 40	73 55 00	15	Flood	11.0	32	0.00	0

TABLE XXVII—Continued

93—SLIPS IN HARLEM RIVER AND EAST RIVER. NOVEMBER 13, 1911

High water at Hell Gate at 3.26 P. M.

Sample No.	Hour P. M.	Location of Samples			Feet below surface	Tidal current	Temp. water Deg. C.	Per cent. land water	Oxygen	
		Approximate	Latitude	Longitude					C. C. per litre	Per cent. saturation
			° ′ ″	° ′ ″						
2327	2.00	Slip south of foot of East 109th street, Harlem river	40 47 24	73 56 11	1	Flood	11.0	30	2.22	33
2328	2.03	Slip south of foot of East 109th street, Harlem river	40 47 24	73 56 11	15	Flood	11.0	30	2.22	33
2329	2.25	Slip south of foot of East 119th street, Harlem river	40 47 45	73 55 47	1	Flood	11.0	30	2.22	33
2330	2.30	Slip south of foot of East 119th street, Harlem river	40 47 45	73 55 47	15	Flood	11.0	30	2.22	33
2331	3.30	Slip at Port Morris, East river	40 48 20	73 54 07	1	Flood	11.0	30	2.78	41
2332	3.35	Slip at Port Morris, East river	40 48 20	73 54 07	15	Flood	11.0	30	2.78	41

94—EAST RIVER AT CLASON POINT, AND LONG ISLAND SOUND AT EXECUTION ROCKS. NOVEMBER 14, 1911

Low water at Governor's Island at 9.00 A. M. High water at 2.50 P. M. Low water at Hell Gate at 10.40 A. M.

	P. M.									
2333	2.00	Long Island Sound at Execution Rocks	40 52 30	73 44 15	1	Flood	10.0	20	6.67	98
2334	3.30	East River, midway between Clason Point and College Point	40 48 00	73 51 11	1	Flood	10.5	26	4.72	69

95—NEWARK BAY. NOVEMBER 15, 1911

Low water at Governor's Island at 10.05 A. M. High water at 4.00 P. M.

	P. M.									
2335	12.30	Newark bay, by bell buoy 2, in channel	40 40 12	74 08 05	1	Ebb	8.00	70	5.56	70

96—HUDSON RIVER OFF WEST 23d STREET, AND OFF MT. ST. VINCENT. NOVEMBER 16, 1911

Low water at Governor's Island at 11.00 A. M. High water at 4.57 P. M.

	P. M.									
2336	12.15	Hudson river off West 23d street, midstream	40 45 09	74 01 00	1	Ebb	9.0	76	4.72	61
2337	1.45	Hudson river off Mt. St. Vincent, midstream	40 54 50	73 55 15	1	Ebb	8.0	88	6.67	81

97—EAST RIVER, UPPER BAY AND LOWER BAY. NOVEMBER 17, 1911

High water at Governor's Island at 5.25 A. M. Low water at 11.55 A. M.
Low water at Sandy Hook at 11.22 A. M. High water at 5.50 P. M.

	A. M.									
2338	9.00	East river off East 23d street, midstream	40 43 56	73 58 05	1	Ebb	9.0	46	4.12	56
2339	10.00	New York Upper Bay by buoy G. 2, in channel	40 40 12	74 03 13	1	Ebb	9.0	44	4.72	65
2340	11.00	New York Lower Bay by buoy A. C. 16, in channel	40 31 42	74 00 34	1	Ebb	9.0	34	6.53	91
2341	11.30	New York Lower Bay by buoy A. C. 2, at outer end of Ambrose channel and of Lower Bay	40 29 54	73 56 10	1	Ebb	9.5	24	6.81	98

98—EAST RIVER OFF EAST 23d STREET, MANHATTAN, NOVEMBER 20, 1911

High water at Governor's Island at 7.30 A. M. Low water at 2.10 P. M.

	P. M.									
2342	1.00	East River, midstream off East 23d street, Manhattan	40 44 00	73 58 05	1	Ebb	9.0	38	4.12	57

INTRODUCTION TO TABLE XXVIII

The determinations of dissolved oxygen made in 1911 differed from those made in 1909 only in respect to the general scheme of collection. The details of collecting and analyzing the samples, as of recording them, with their locations, were the same. The same persons were connected with the work as before.

In the year 1911 more attention was given to the collection of samples in cross-sections of the main tidal channels in different parts of the harbor than had been attempted in 1909. In fact, the distribution of the points from which water was taken for analysis was so different in these two years that if general averages are made to show the condition of the water in the various parts of the harbor, they are likely to give the impression that the water of the harbor was more polluted in 1911 than in 1909, whereas a consideration of the rainfall, temperature and amount of sewage entering the water in these two years does not explain how this can be true.

Distinction Between Tide and Current

The principal object of the work in the cross-sections was to determine the extent to which the water varied at different stages of tidal flow. Inasmuch as the condition of water moving in the main currents of the tidal channels was of essential importance, reference is made in the tables to the currents more than to the elevations of tide. To avoid any confusion which might arise, the distinction between current and tide should be kept in mind. By current is meant the flow of water past a given point, usually seaward or landward. These flows are sometimes termed ebb current and flood current respectively.

By stage of tide is meant the relative elevation of the surface of the water. In some parts of the harbor, and especially in the Hudson river, there is no strict correspondence between the stage of tide and the direction of current. Ebb current sometimes continues long after the flood tide has set in. It is not uncommon for a flood current to begin along the bottom of a channel before the ebb current ceases at the surface. This is true at the Narrows, for example. The existence of these counter-currents could easily be detected by the collector in taking a sample of water from near the bottom, but it has not been feasible to describe each current that has been encountered. Where flood current is stated in the table, the prevailing direction at the surface of the water is meant, and there is no reference to the existence of any other current below. To avoid confusion, the westward-flowing current in the Upper East river is called the ebb, and the eastward the flood, regardless of the fact that the water sometimes rises with the westward current.

METHOD OF SAMPLING AT CROSS-SECTIONS

In studying the cross-sections, it was usual to collect a sample from each of three depths at from three to five points across the tidal stream. One group of samples collected in this way has been termed a set of samples. A number of sets collected over a period of some hours has been known as a series. In many cases a series has extended throughout the continuance of an ebb or flood current. When so many samples have been taken that the number of sets was sufficient to cover a complete revolution of ebb and flood currents, the group of samples was termed a cycle.

AVOIDANCE OF LOCAL CONTAMINATION

In collecting samples, care was taken to avoid water obviously contaminated from a local source. No cross-section was studied, any part of which was in the immediate vicinity of a sewer outfall. The samples taken nearest shore have, in all cases, been sufficiently far away from the land to avoid streams of unusually heavily-polluted water.

The order in which the cross-sections have been examined has been such as to give knowledge of the relative condition of the water at the most important points at as near the same time as practicable.

Table XXVIII contains a summary of averages of the oxygen found at various cross-sections without regard to current, on ebb currents and on flood currents.

TABLE XXVIII

Average Volume and Percentage of Saturation of Dissolved Oxygen in the Water in the year 1911

Averages of Samples taken in Cross-sections of the Tidal Channels

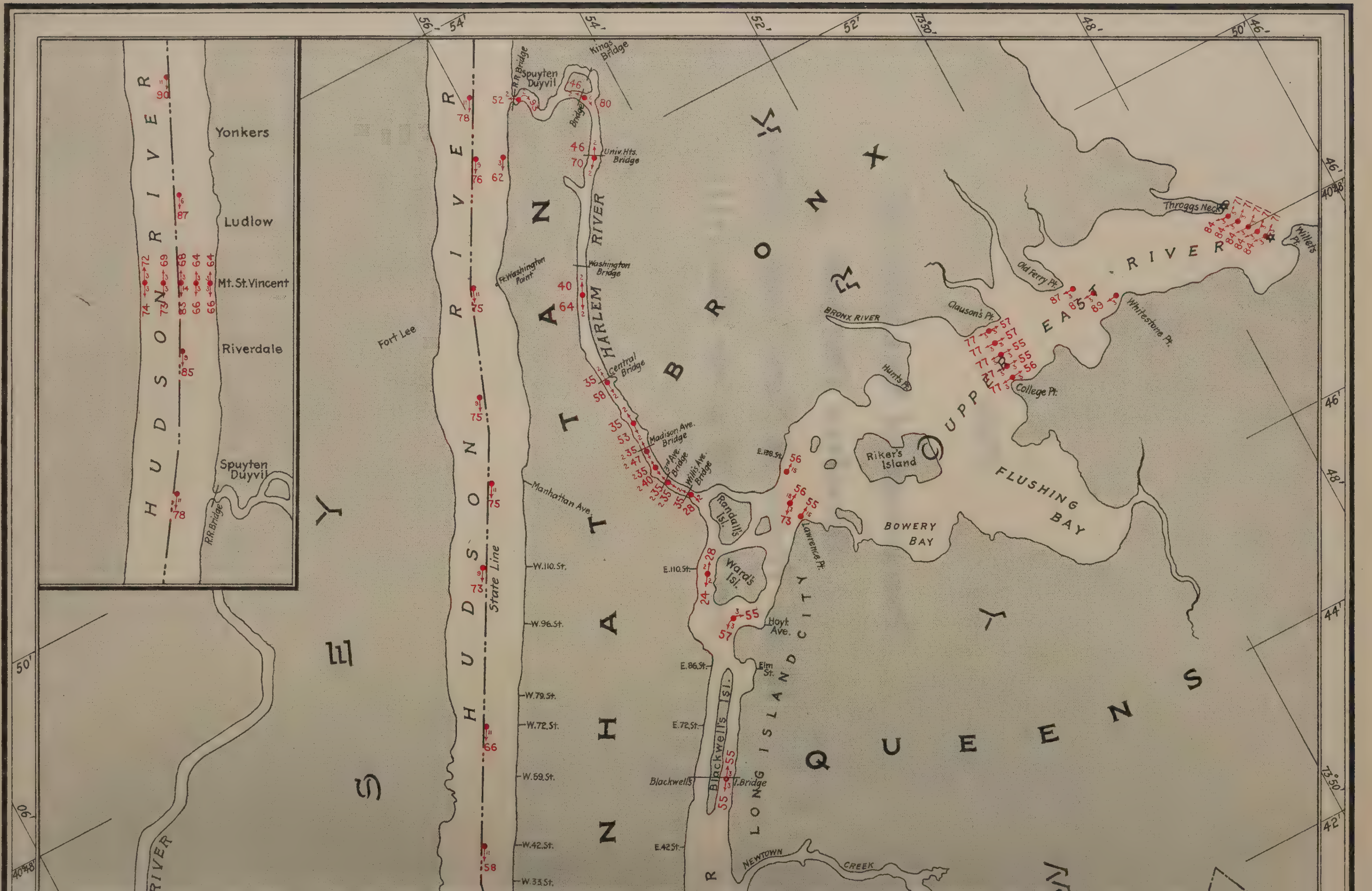
Data for this table are contained in Table XXVII.

Location	Dissolved Oxygen						Number of Samples	Date	Samples included in the Averages
	Both Currents		Ebb Current		Flood Current				
	C. C. Per Litre	Per Cent of Saturation	C. C. Per Litre	Per Cent of Saturation	C. C. Per Litre	Per Cent of Saturation		1911	Nos.
Hudson river, at Mt. St. Vincent	4.11	69	4.19	70	4.04	67	30	June 29	23–52
	5.08	76	5.35	80	4.80	72	90	Oct. 13	1948–2037
	4.60	72	4.77	75	4.42	70	120		
Hudson river at the mouth	—	—	3.14	56	—	—	15	July 19	463–477
	3.11	56	3.02	54	3.20	58	45	July 20	478–522
	2.99	55	2.84	52	3.14	58	45	Aug. 10	903–947
	3.18	56	3.06	53	3.31	58	105	Sept. 28	1579–1683
	3.09	56	3.01	54	3.22	58	210		
East river, at Throgs Neck	5.23	86	5.41	89	5.05	82	54	Oct. 25	2173–2226
East river, at Clason Point	3.72	67	4.24	77	3.20	56	30	June 30	53–67, 77–91
East river, at Lawrence Point	—	—	—	—	3.05	56	45	July 18	418–462
	3.43	57	3.58	60	3.28	54	54	Oct. 11	1894–1947
	3.43	57	3.58	60	3.16	55	99		
East river, at the mouth	3.01	55	2.90	53	3.12	57	45	July 27	598–642
	3.04	56	2.93	54	3.14	57	45	Aug. 3	768–812
	3.08	54	2.95	52	3.21	57	90	Sept. 29	1684–1773
	3.04	55	2.93	53	3.16	57	180		
Kill van Kull, east end	4.43	75	4.41	74	4.45	76	54	Oct. 4	1774–1827
The Narrows at forts	—	—	3.86	72	—	—	27	Aug. 9	876–902
	4.42	79	4.28	76	4.57	82	105	Sept. 26	1474–1578
	4.42	79	4.07	74	4.57	82	132		
Upper bay in vicinity of Robbin's Reef	4.29	71	4.03	66	4.55	76	45	Oct. 16	2038–2082
	4.62	73	4.44	70	4.79	77	36	Oct. 23	2083–2094, 2098–2109, 2113–2124
	4.89	76	5.14	80	4.64	73	36	Oct. 24	2128–2139, 2143–2154, 2158–2169
	4.60	73	4.54	72	4.66	75	117		
Newark bay, lower end	4.02	64	4.22	67	3.82	61	66	Oct. 6	1828–1893

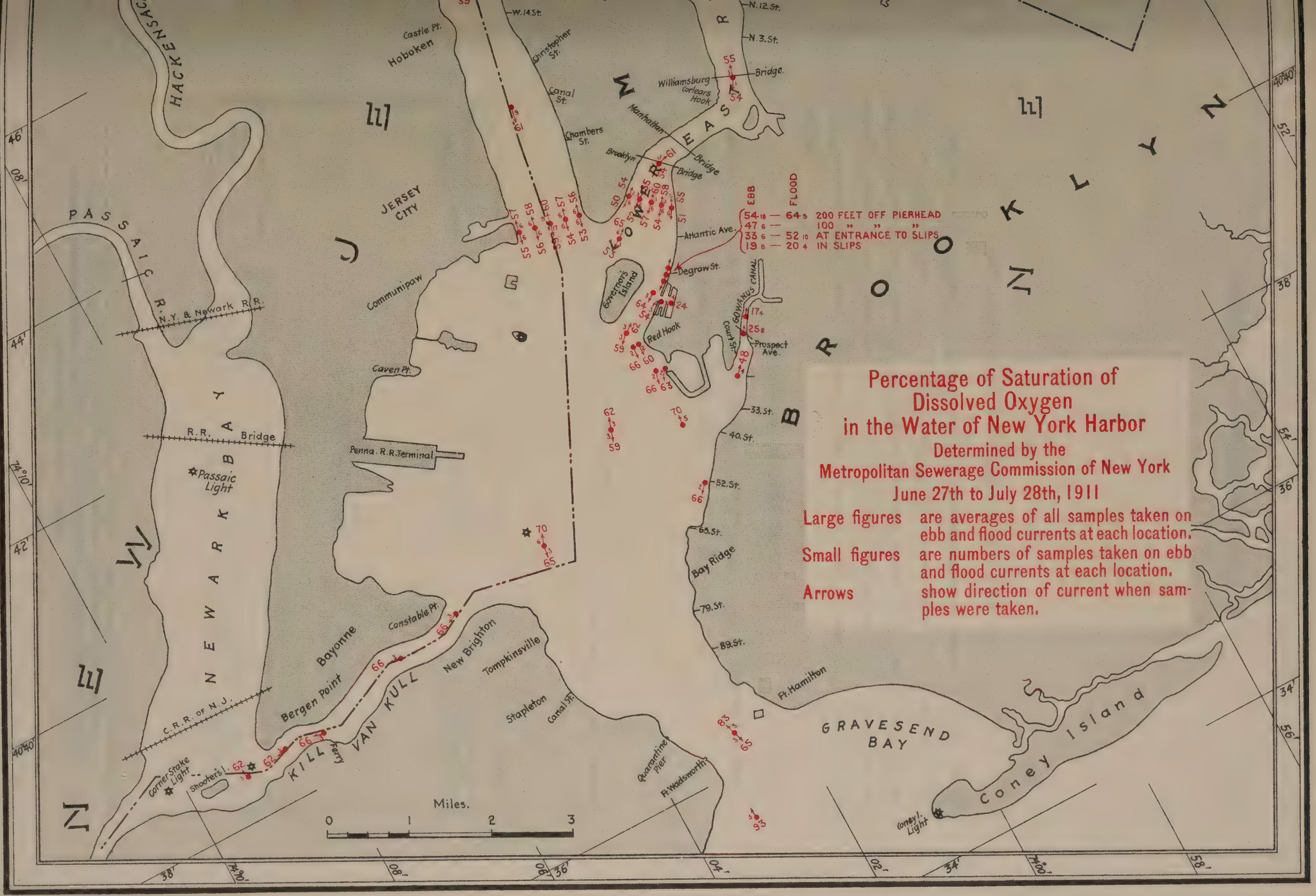
Plate G

Percentage of Saturation of Dissolved Oxygen in the Water of New York Harbor

from June 27th to July 28th, 1911



HUDSON RIVER
Yonkers
Ludlow
Mt. St. Vincent
Riverdale
Spuyten Duyvil
R.R. Bridge
HUDSON RIVER
State Line
Fort Lee
NEW JERSEY
RIVER
MANHATTAN
Spuyten Duyvil
R.R. Bridge
Kings Bridge
Bridge
Univ. Hts. Bridge
Ft. Washington Point
Washington Bridge
HARLEM RIVER
Central Bridge
Madison Ave. Bridge
3rd Ave. Bridge
Willis Ave. Bridge
Manhattan Ave.
W. 110 St.
W. 96 St.
W. 79 St.
W. 72 St.
W. 59 St.
W. 42 St.
W. 33 St.
E. 138 St.
E. 110 St.
E. 86 St.
E. 72 St.
E. 42 St.
Blackwells
Blackwell's Isl.
Bridge
Randall's Isl.
Ward's Isl.
Hoyt Ave.
Elm St.
LONG ISLAND CITY
NEWTOWN CREEK
Lawrence Pt.
BRONX
BRONX RIVER
Hunts Pt.
Clauson's Pt.
Old Ferry Pt.
Throggs Neck
Willets Pt.
Whitestone Pt.
College Pt.
UPPER EAST RIVER
Riker's Island
FLUSHING BAY
BOWERY BAY
QUEENS
56'
54'
54'
52'
52'
73°50'
48'
50'
46'
40°48'
46'
46'
48'
44'
73°50'
42'
50'
06'
40°48'



Percentage of Saturation of Dissolved Oxygen in the Water of New York Harbor

Determined by the Metropolitan Sewerage Commission of New York

June 27th to July 28th, 1911

Large figures are averages of all samples taken on ebb and flood currents at each location.

Small figures are numbers of samples taken on ebb and flood currents at each location.

Arrows show direction of current when samples were taken.

EBB	FLOOD	
54 10	64 9	200 FEET OFF PIERHEAD
47 6		100 " " "
33 6	52 10	AT ENTRANCE TO SLIPS
19 8	20 4	IN SLIPS

Plotted from Data Contained in Table XXVII, pp. 345–363.

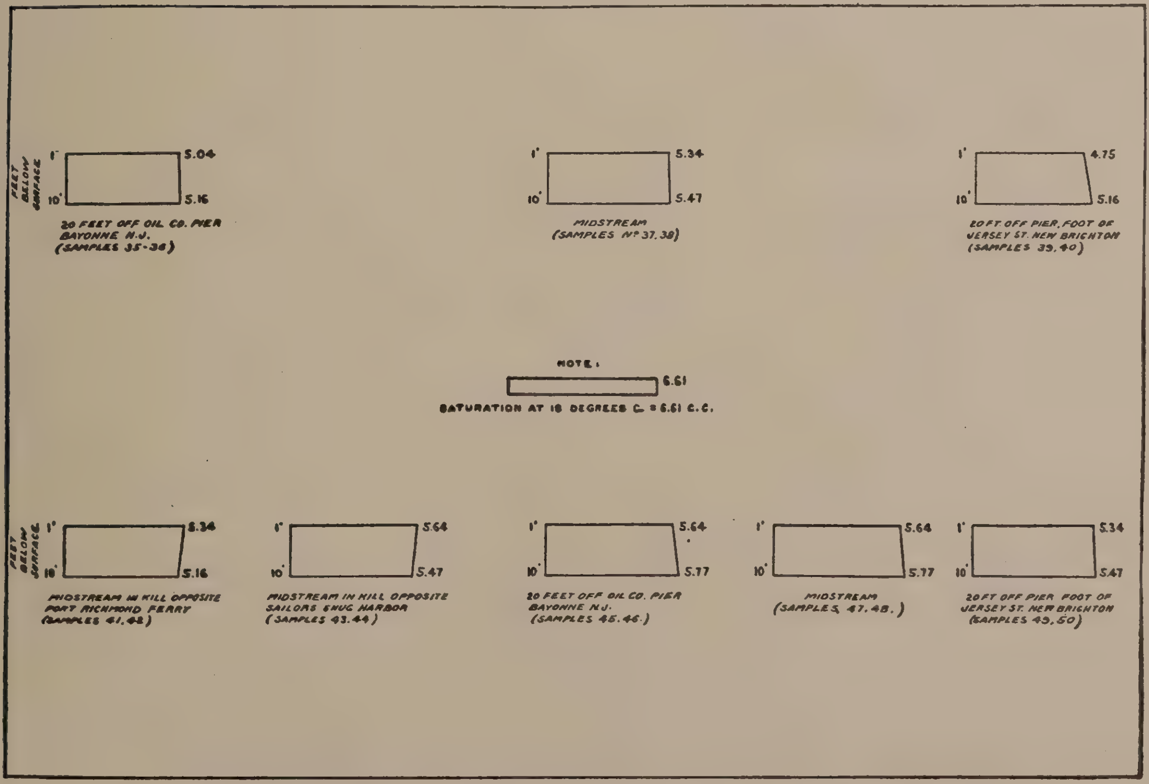
INTRODUCTION TO OXYGEN DIAGRAMS I

Following is a series of diagrams showing the quantities of dissolved oxygen in the water at various points and at different depths in the year 1909. The numbers of the samples employed are indicated, together with a description of the locality and the dissolved oxygen in cubic centimeters per litre. Other information with respect to the circumstances under which the samples were collected can be found in Table XXI, pp. 308-336.

OXYGEN DIAGRAMS I

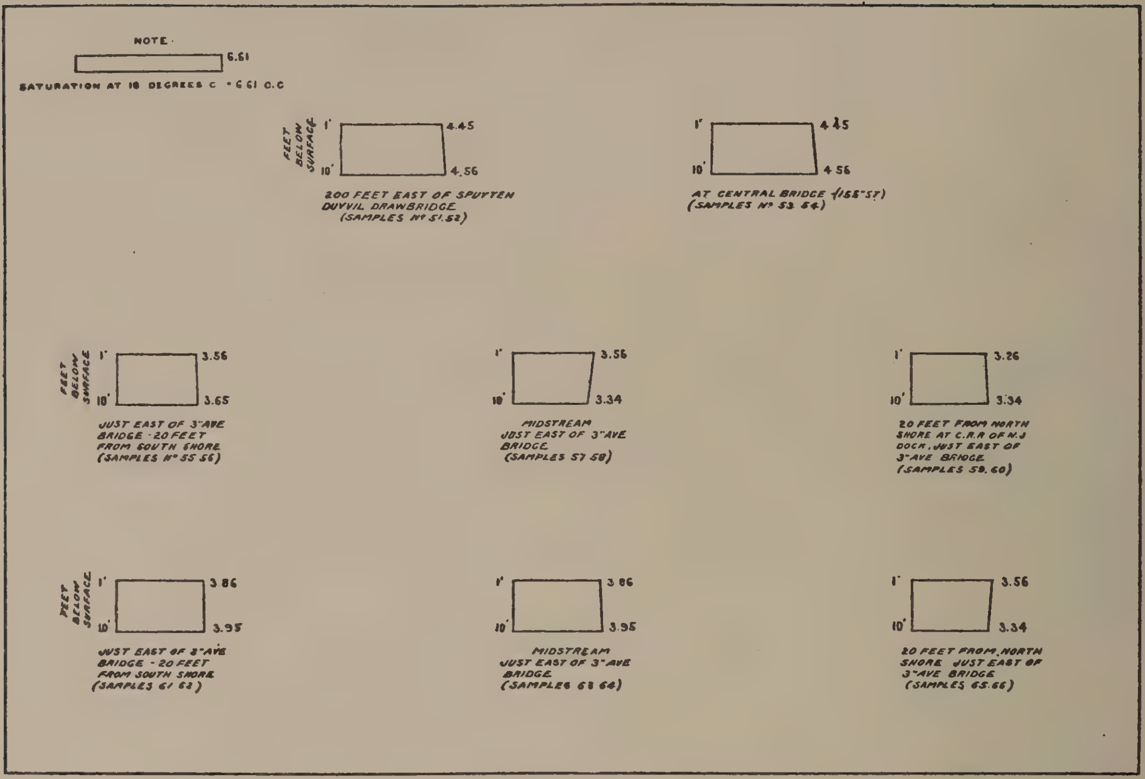
Diagrams showing volumes of dissolved oxygen in the water at different depths in various parts of the harbor in the year 1909.

FIG. 86



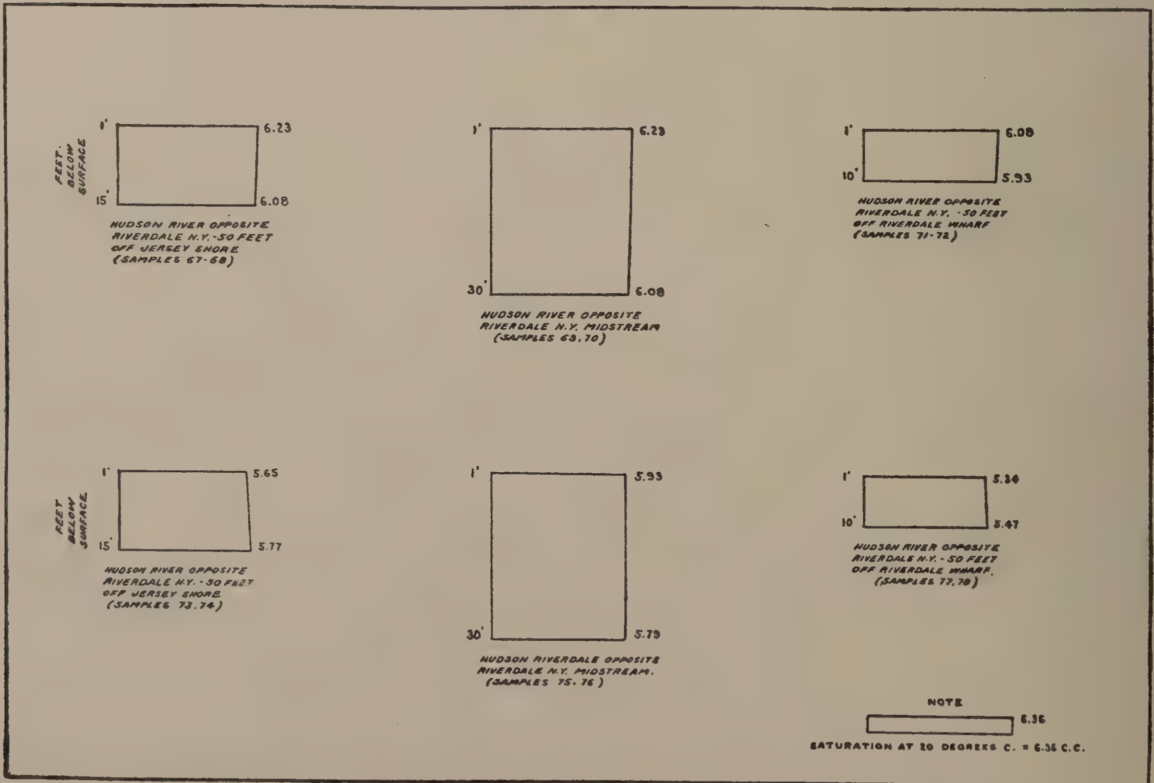
ACROSS KILL VAN KULL FROM COLUMBIA OIL CO. PIER. BAYONNE N.J. TO JERSEY ST. NEW BRIGHTON
DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C. PER LITRE
SAMPLES COLLECTED JUNE 1ST 1909

FIG. 87



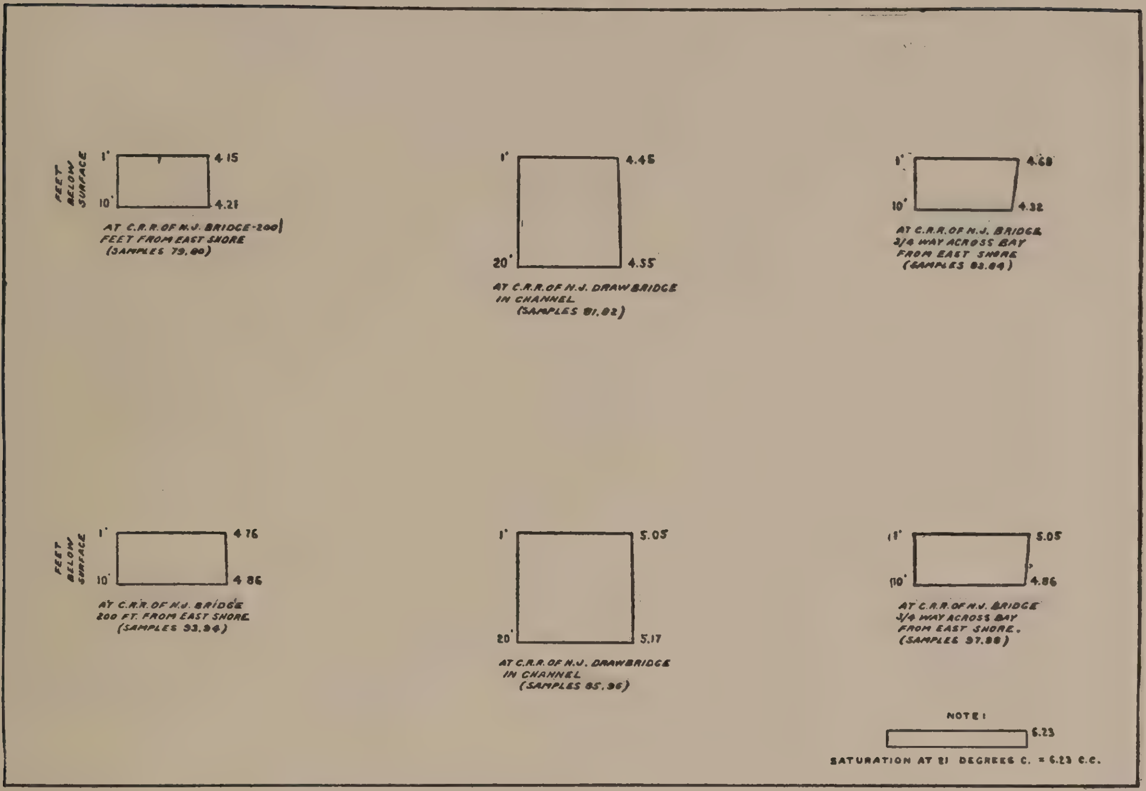
ACROSS HARLEM RIVER AT 3RD AVE. BRIDGE AND AT TWO OTHER POINTS IN HARLEM RIVER
DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C PER LITRE
SAMPLES COLLECTED JUNE 2ND 1909

FIG. 88



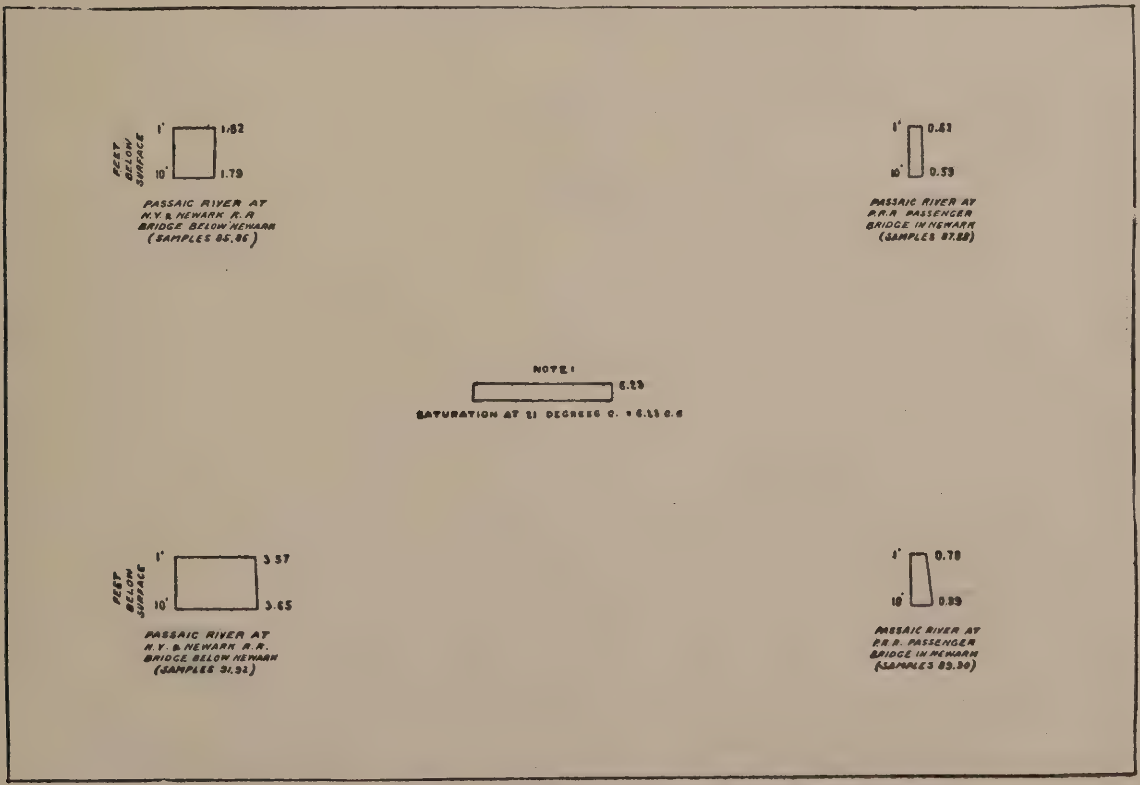
ACROSS HUDSON RIVER FROM RIVERDALE NEW YORK
DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C. PER LITRE
SAMPLES COLLECTED JUNE 16TH 1909

FIG. 89



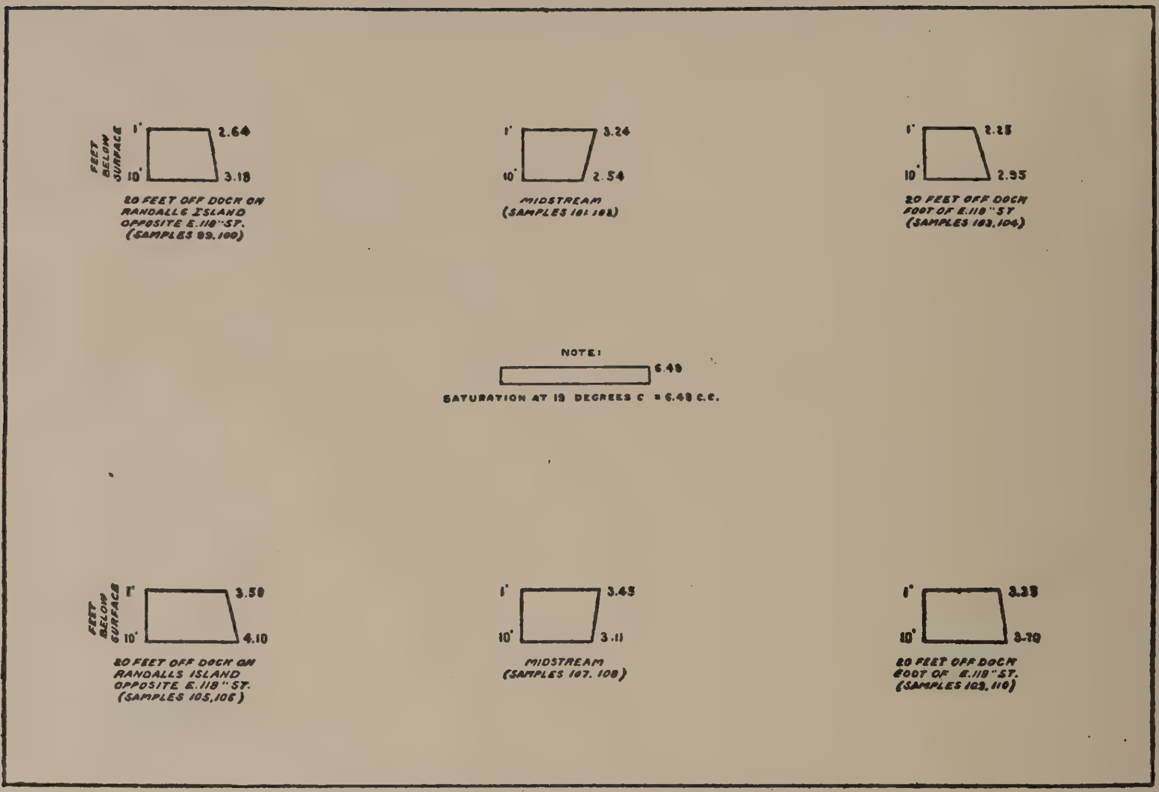
ACROSS NEWARK BAY AT THE C.R.R. OF N.J. BRIDGE
DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C. PER LITRE
SAMPLES COLLECTED JUNE 17TH 1909

FIG. 90



PASSAIC RIVER AT N.Y. & NEWARK R.R. BRIDGE BELOW NEWARK & AT P.R.R. BRIDGE IN NEWARK
DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C. PER LITRE
SAMPLES COLLECTED JUNE 17TH 1909

FIG. 91

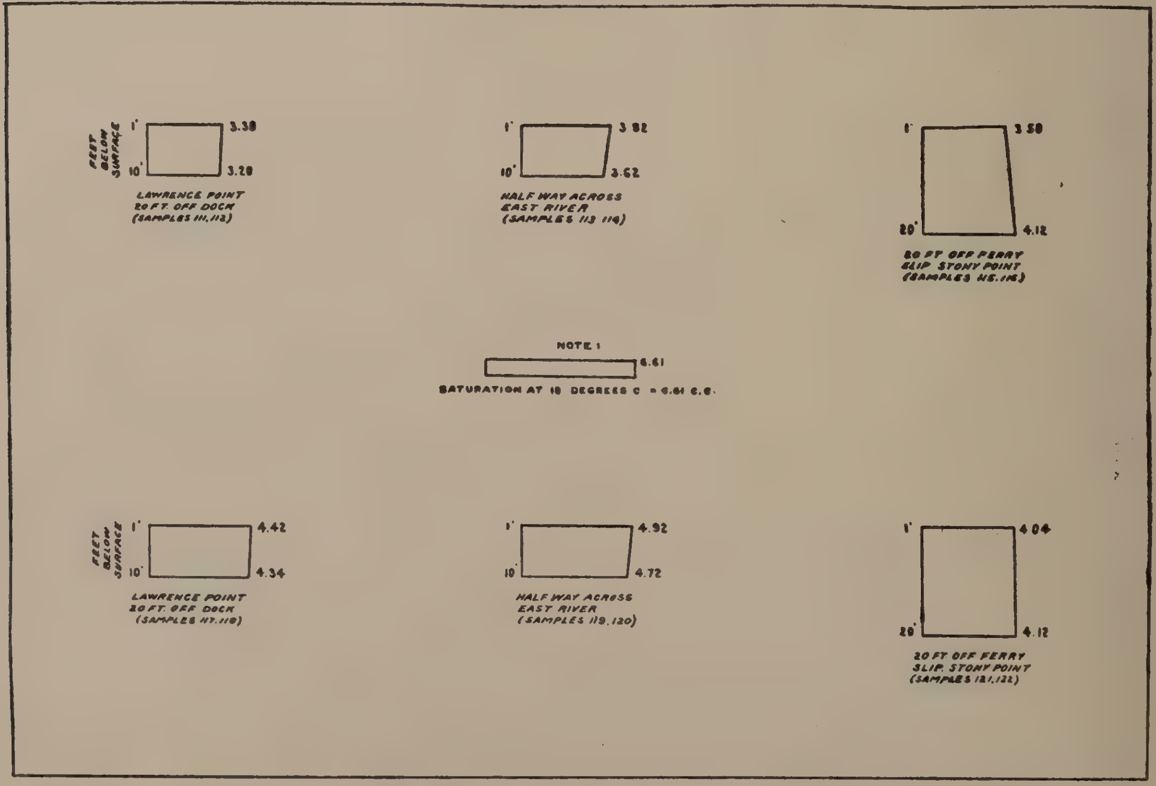


ACROSS HARLEM RIVER FROM FOOT OF E.118TH ST. TO RANDALL'S ISLAND

DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C. PER LITRE

SAMPLES COLLECTED JUNE 21ST 1909

FIG. 92

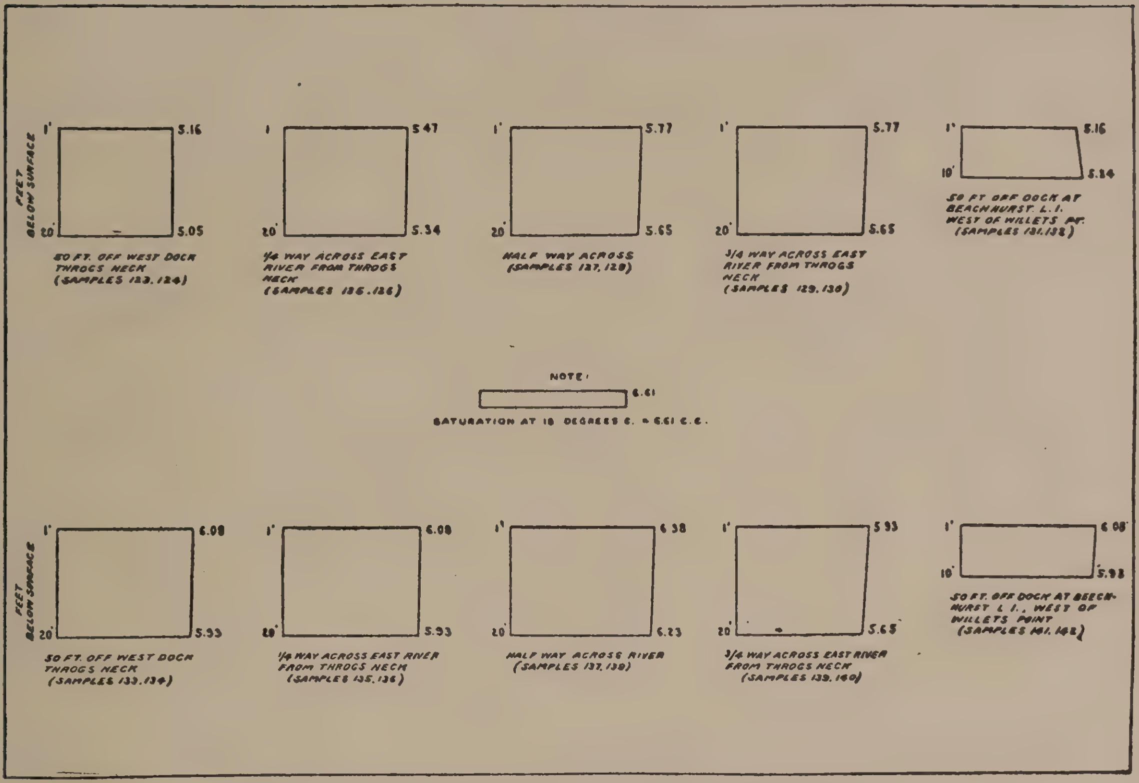


ACROSS EAST RIVER FROM LAWRENCE POINT, L.I. TO STONY POINT, BRONX

DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C PER LITRE

SAMPLES COLLECTED JUNE 21ST 1909

FIG. 93

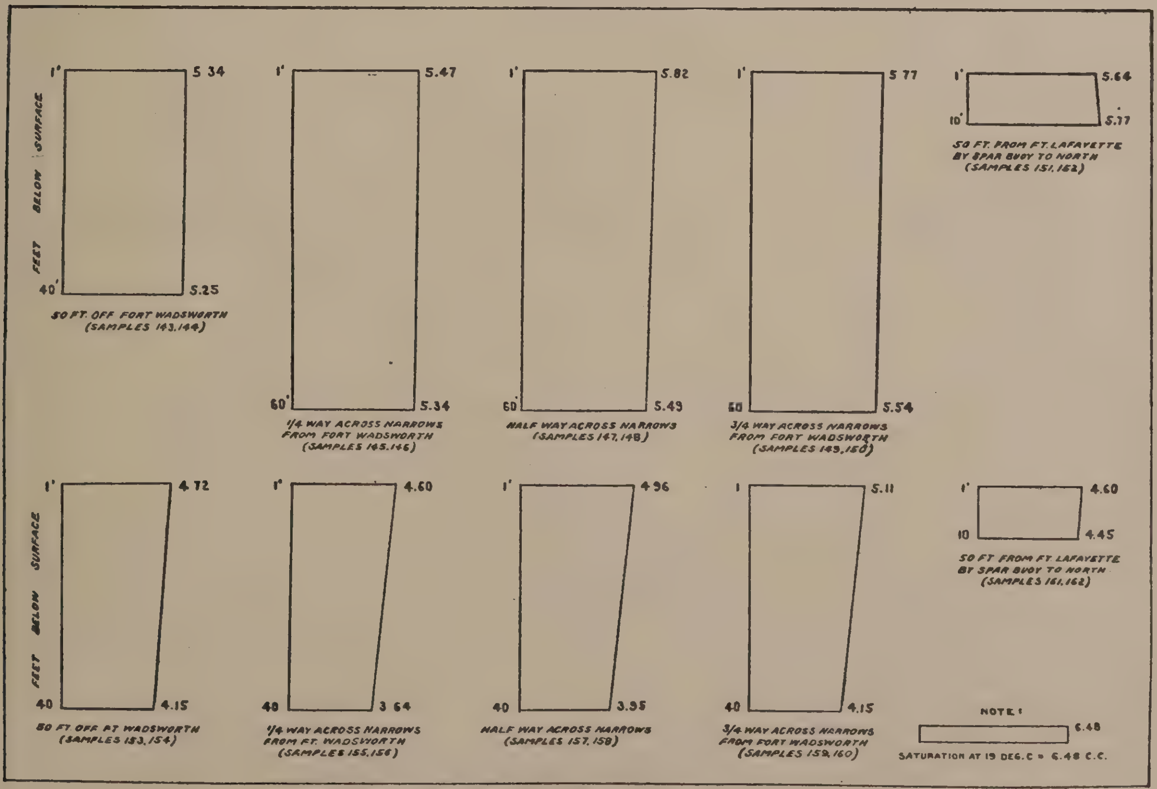


ACROSS EAST RIVER FROM THROGS NECK, BRONX TO BEECHHURST L. I.

DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C. PER LITRE

SAMPLES COLLECTED JUNE 23RD 1909

FIG. 94

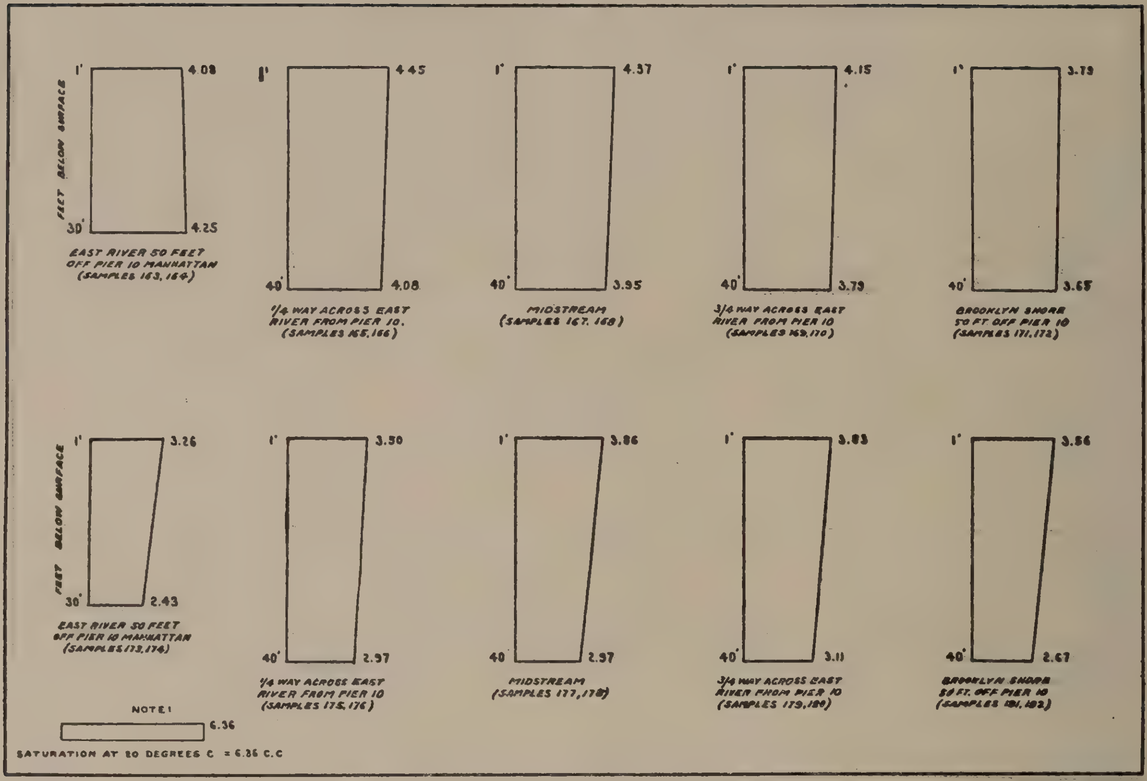


ACROSS NARROWS FROM FORT WADSWORTH TO FORT LAFAYETTE

DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE RESULTS IN C.C. PER LITRE

SAMPLES COLLECTED JUNE 21ST 1909

FIG. 95

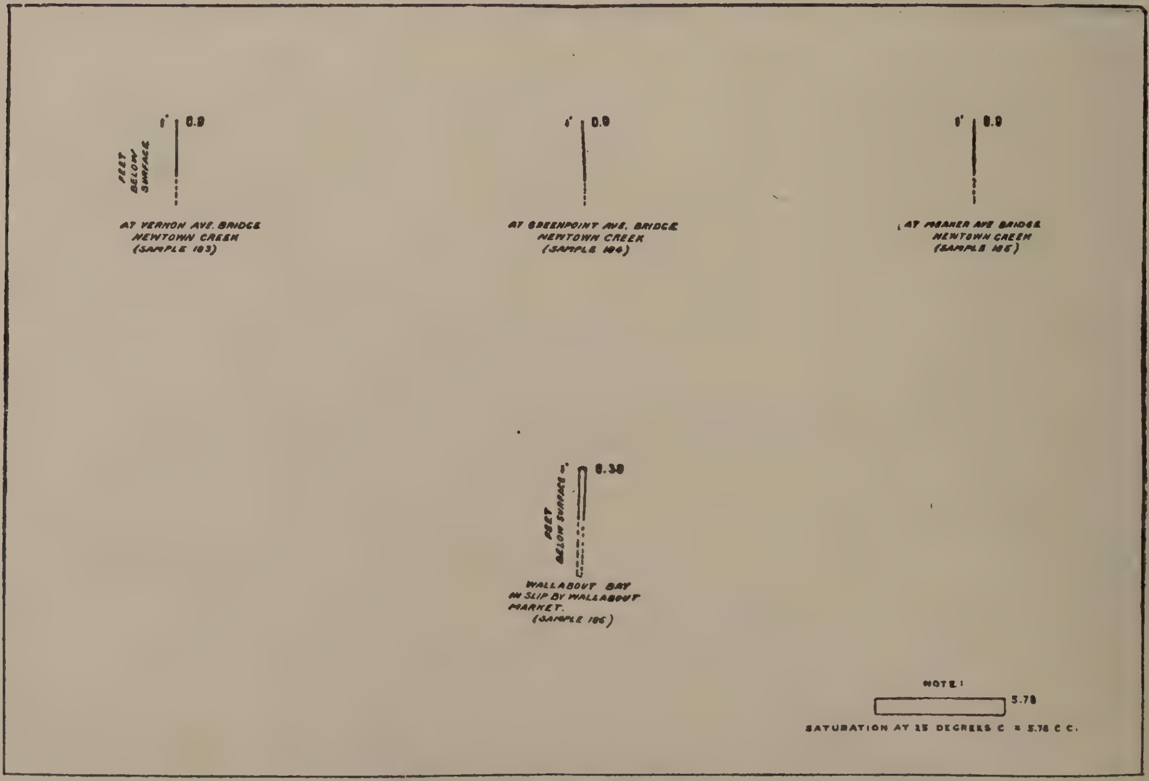


ACROSS EAST RIVER JUST BELOW BROOKLYN BRIDGE.

DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C. PER LITRE

SAMPLES COLLECTED JUNE 25TH 1909

FIG. 96

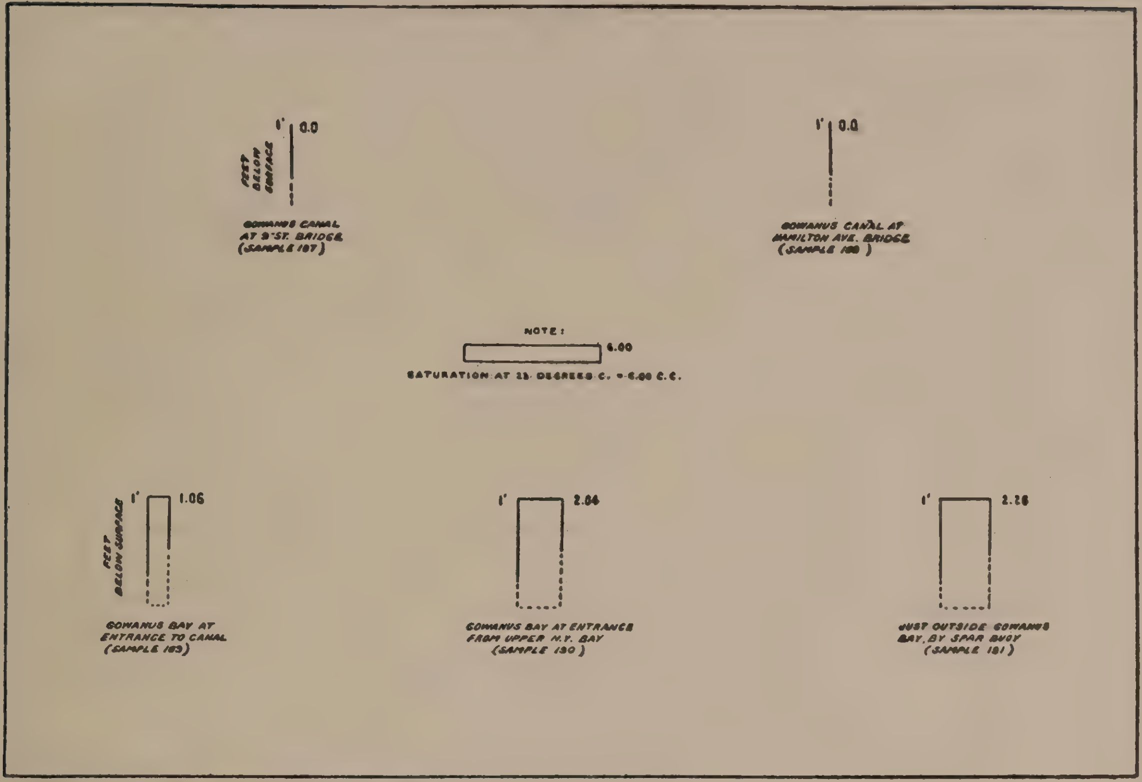


NEWTOWN CREEK AND WALLABOUT BAY

DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C C PER LITRE

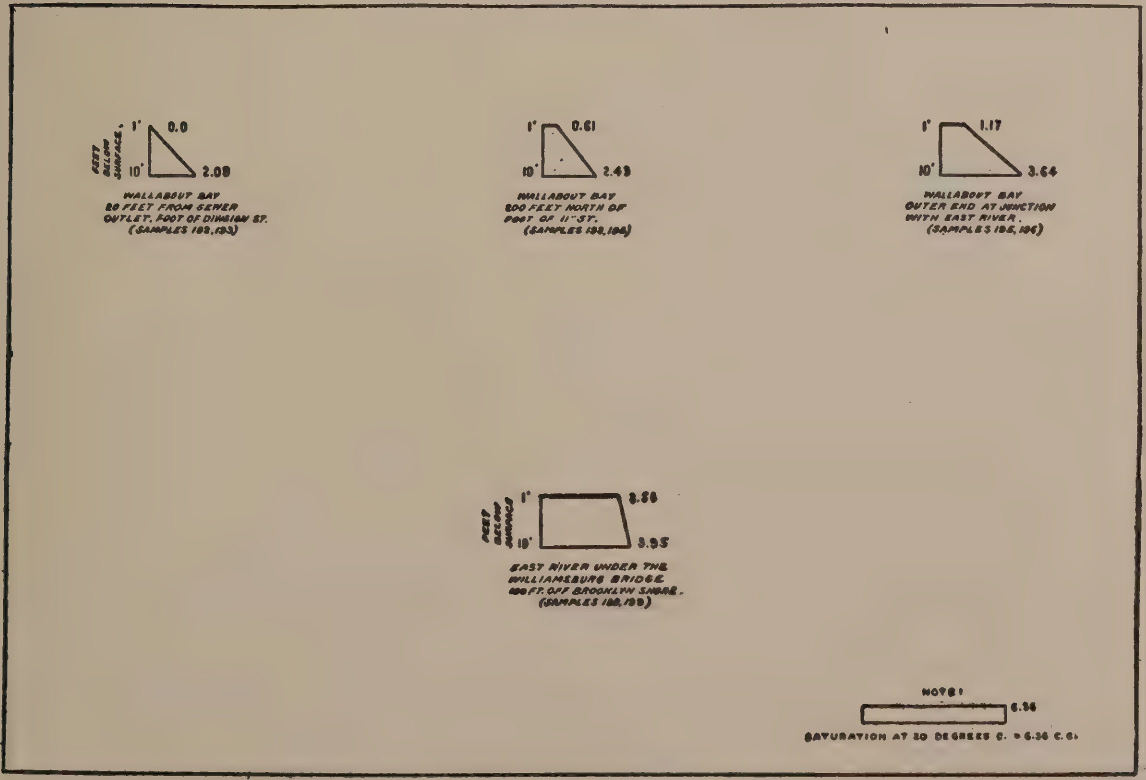
SAMPLES COLLECTED JUNE 25TH 1909

FIG. 97



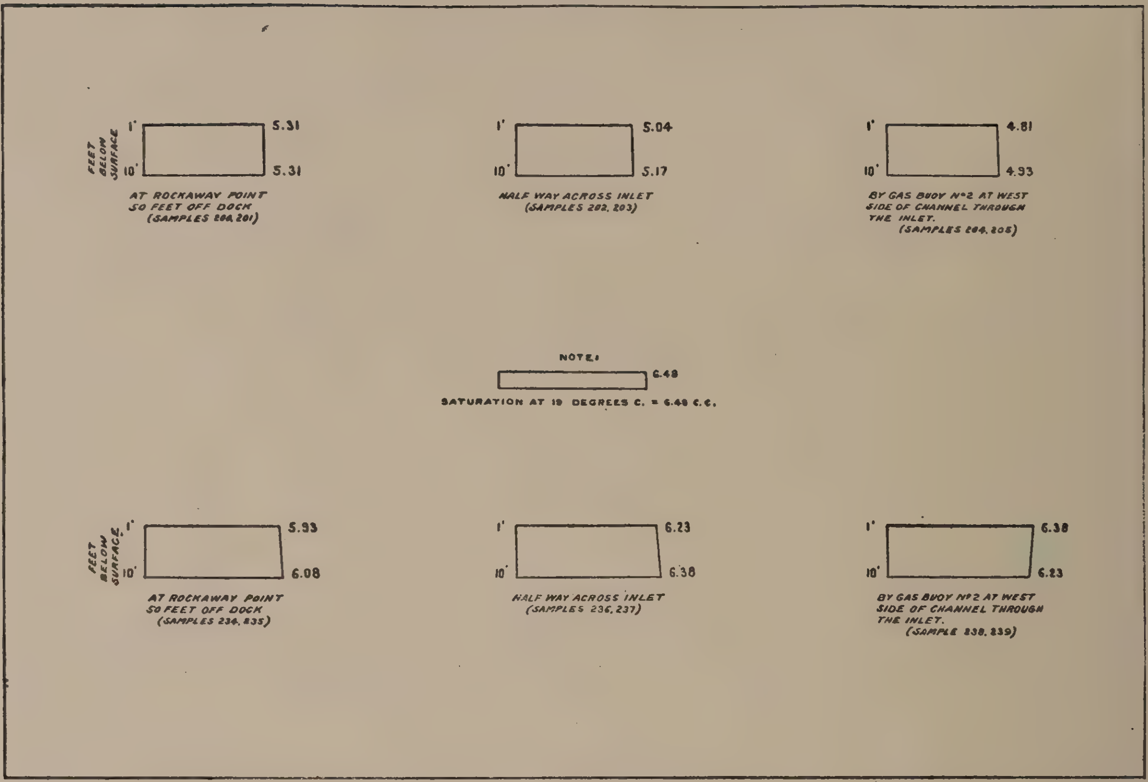
IN GOWANUS BAY AND CANAL
DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE – RESULTS IN C.C. PER LITRE
SAMPLES COLLECTED JUNE 26TH 1909

FIG. 98



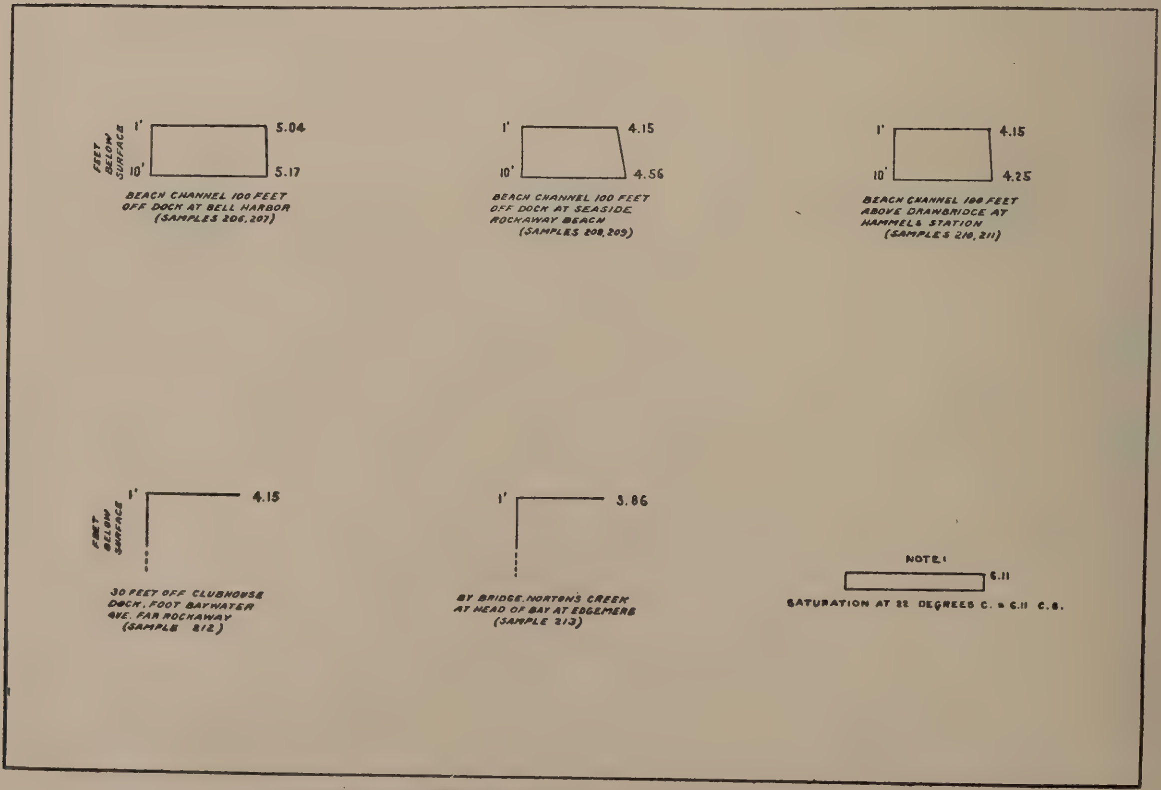
WALLABOUT BAY AND EAST RIVER
DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE – RESULTS IN C.C. PER LITRE
SAMPLES COLLECTED JUNE 28TH 1909

FIG. 99



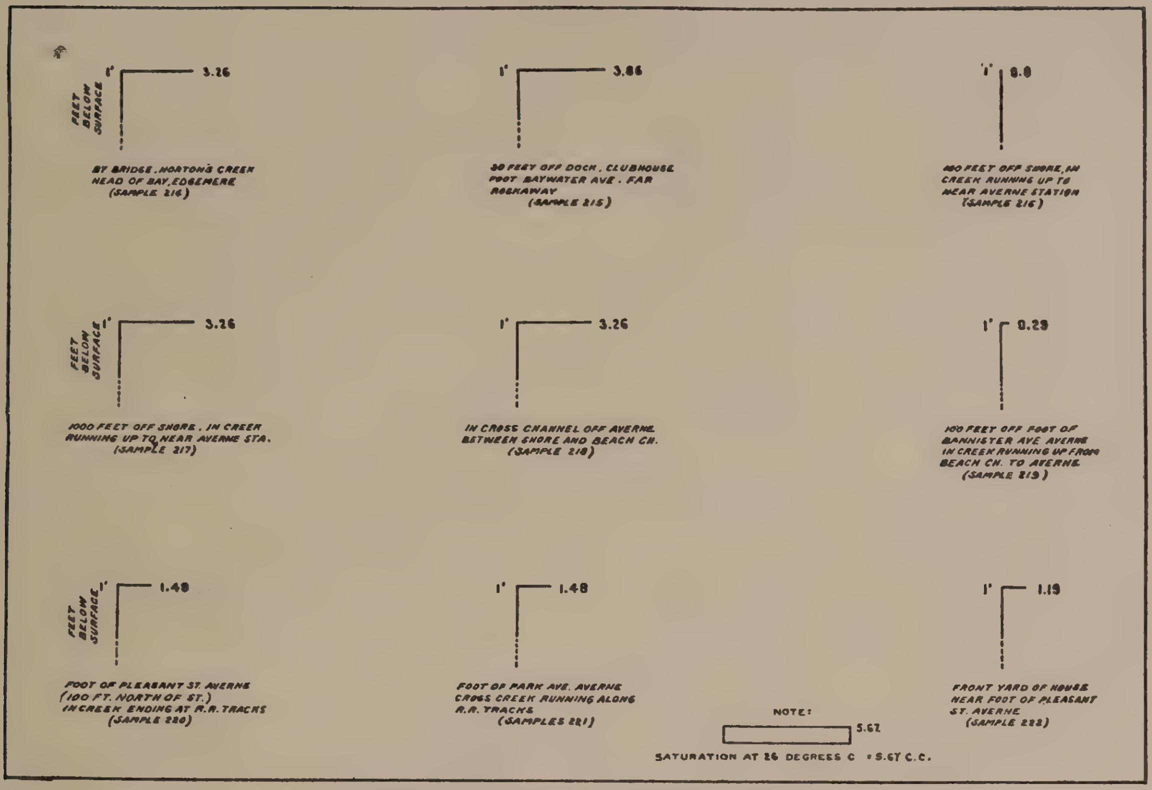
ACROSS ROCKAWAY INLET
DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C. PER LITRE
SAMPLES COLLECTED JUNE 29TH AND JULY 5TH 1909

FIG. 100



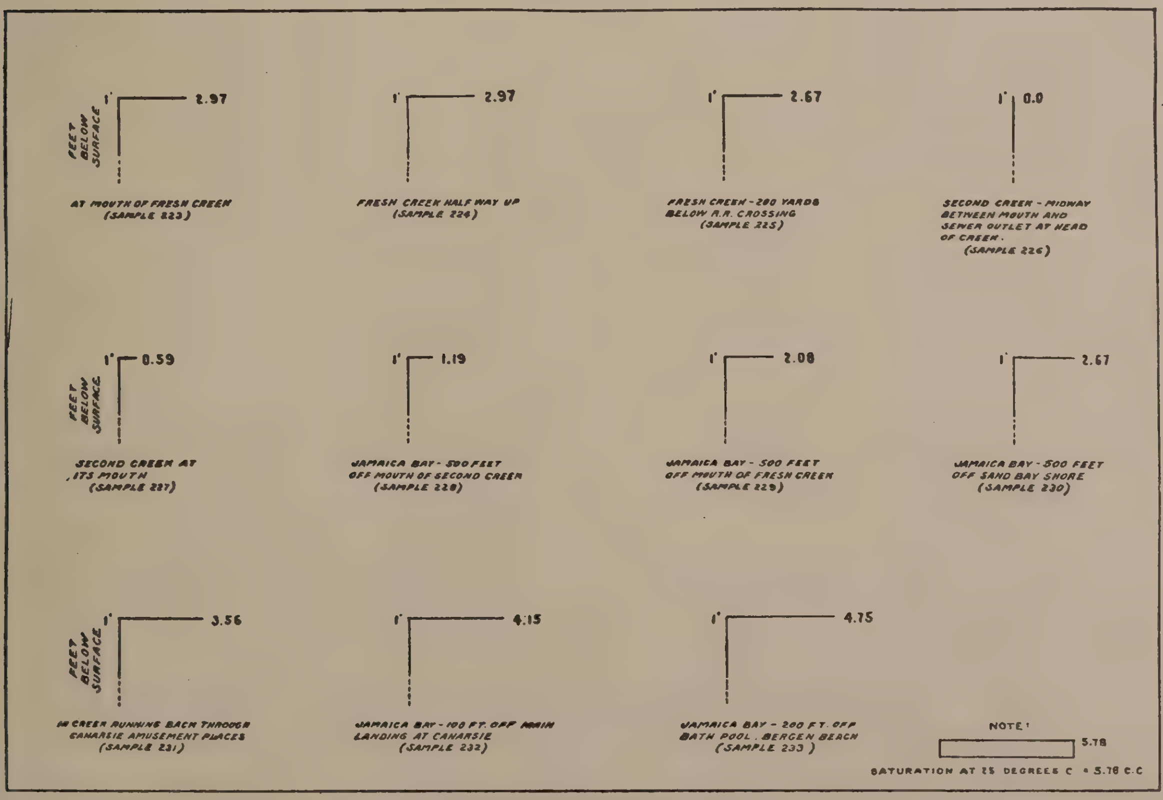
JAMAICA BAY - IN BEACH CHANNEL - ROCKAWAY SIDE OF BAY
DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C. PER LITRE
SAMPLES COLLECTED JUNE 29TH 1909

FIG. 101



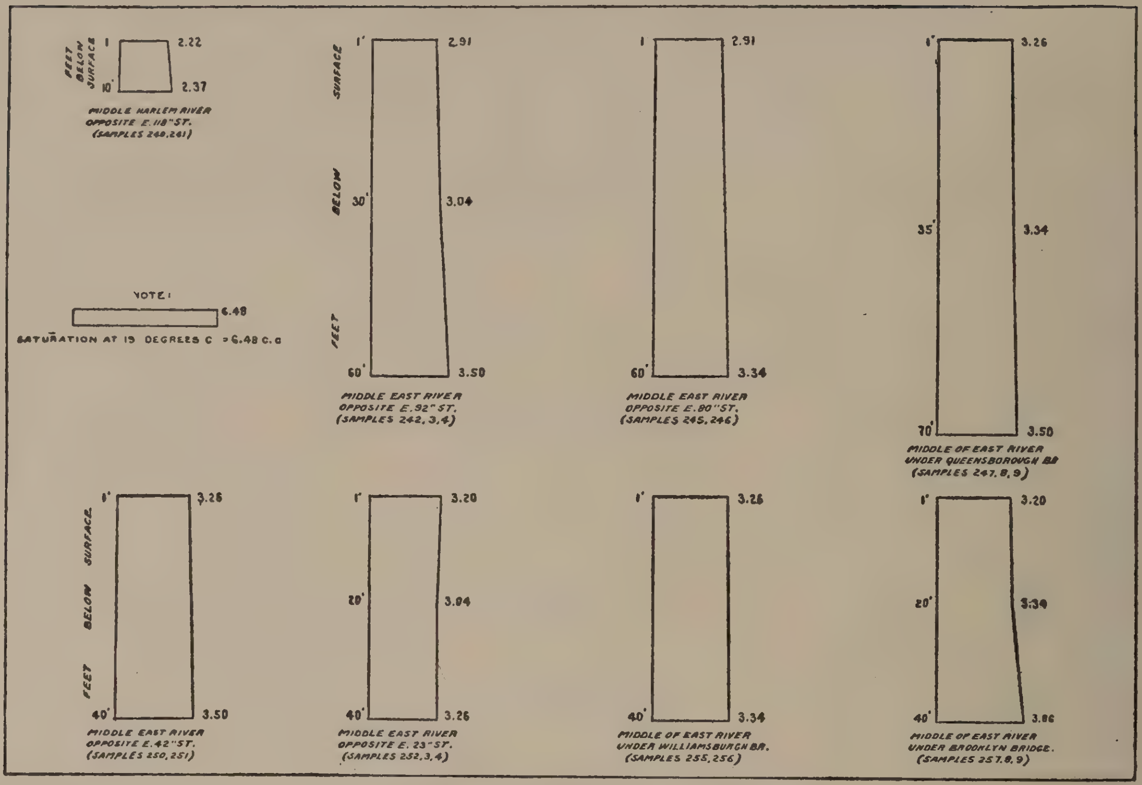
JAMAICA BAY-AVERNE AND ROCKAWAY SHORES
DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C. PER LITRE
SAMPLES COLLECTED JUNE 30TH 1909

FIG. 102



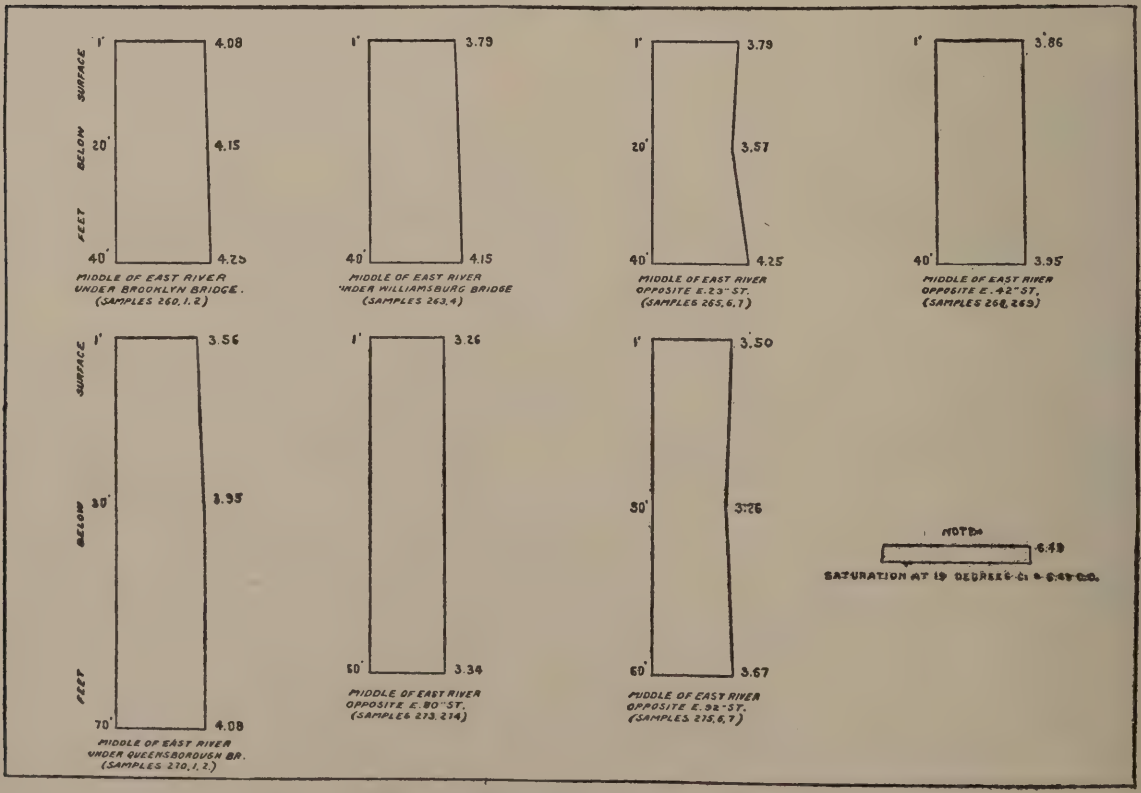
JAMAICA BAY - BROOKLYN SIDE
DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C PER LITRE
SAMPLES COLLECTED JULY 5TH 1909

FIG. 103



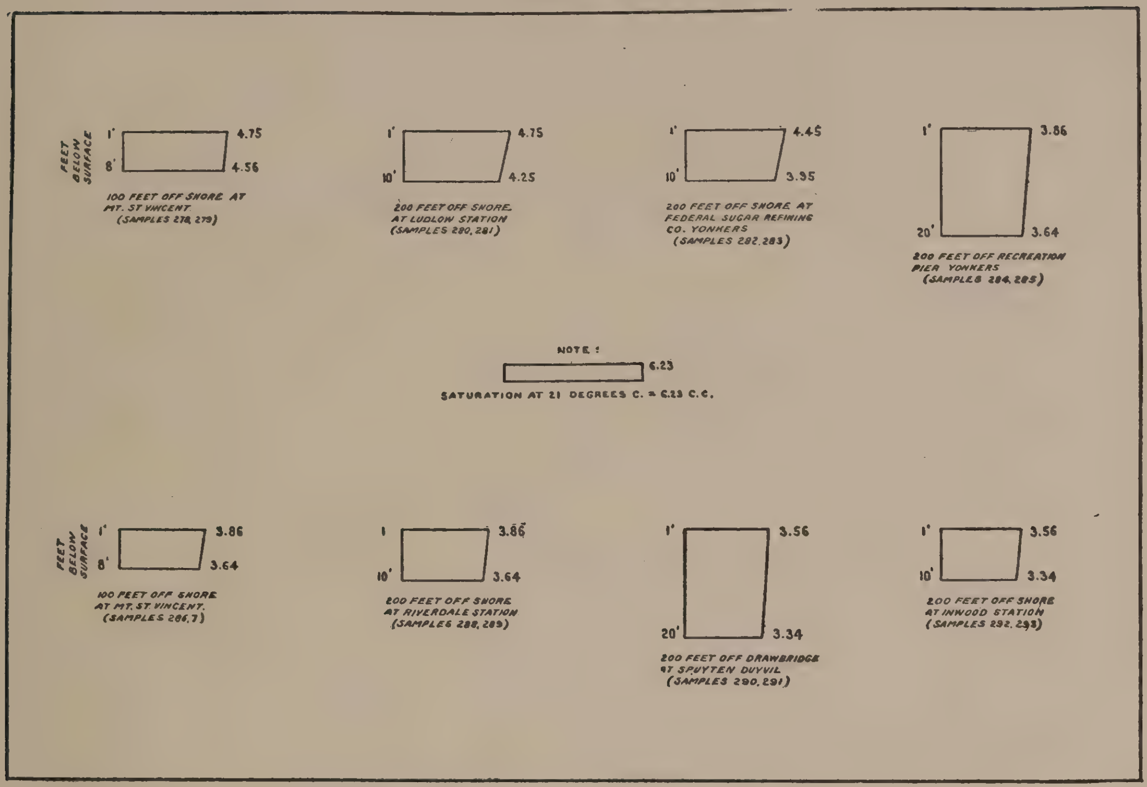
EAST RIVER - HELL GATE TO BROOKLYN BRIDGE
DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C. PER LITRE
SAMPLES COLLECTED ON JULY 2ND 1909

FIG. 104



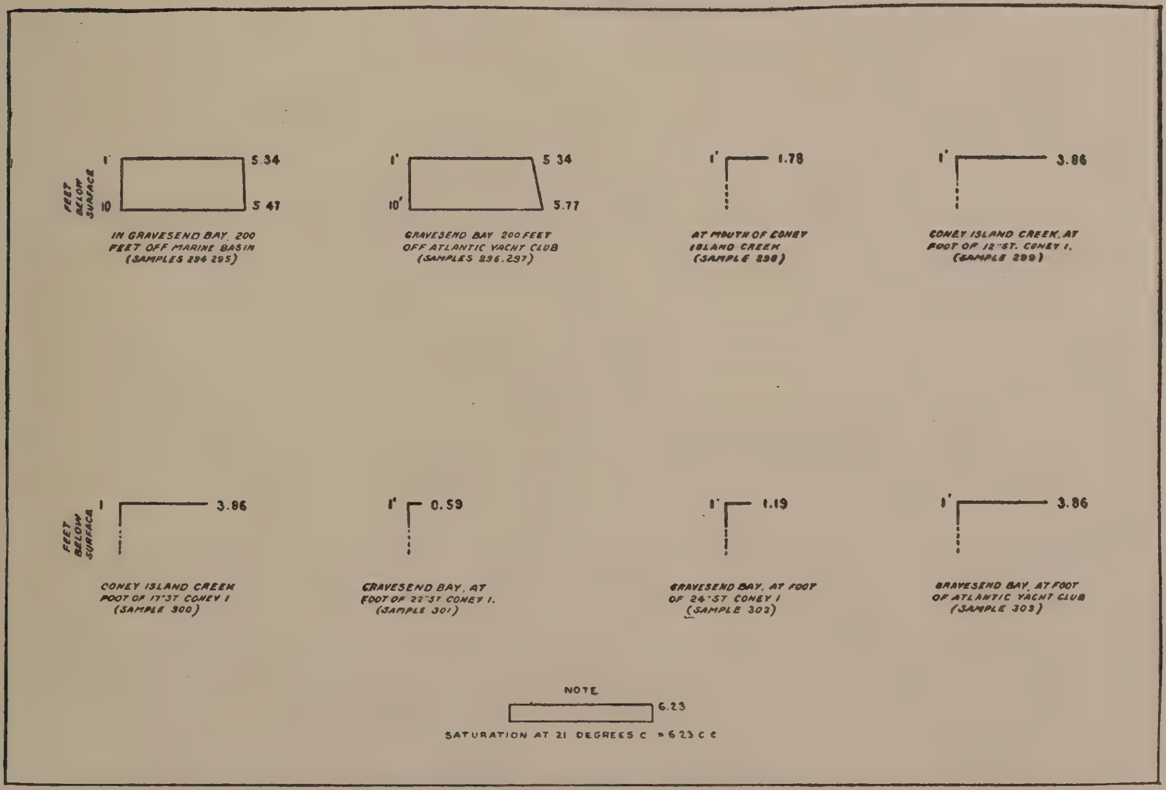
EAST RIVER - BROOKLYN BRIDGE TO HELL GATE
DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C. PER LITRE
SAMPLES COLLECTED JULY 3RD 1909

FIG. 105



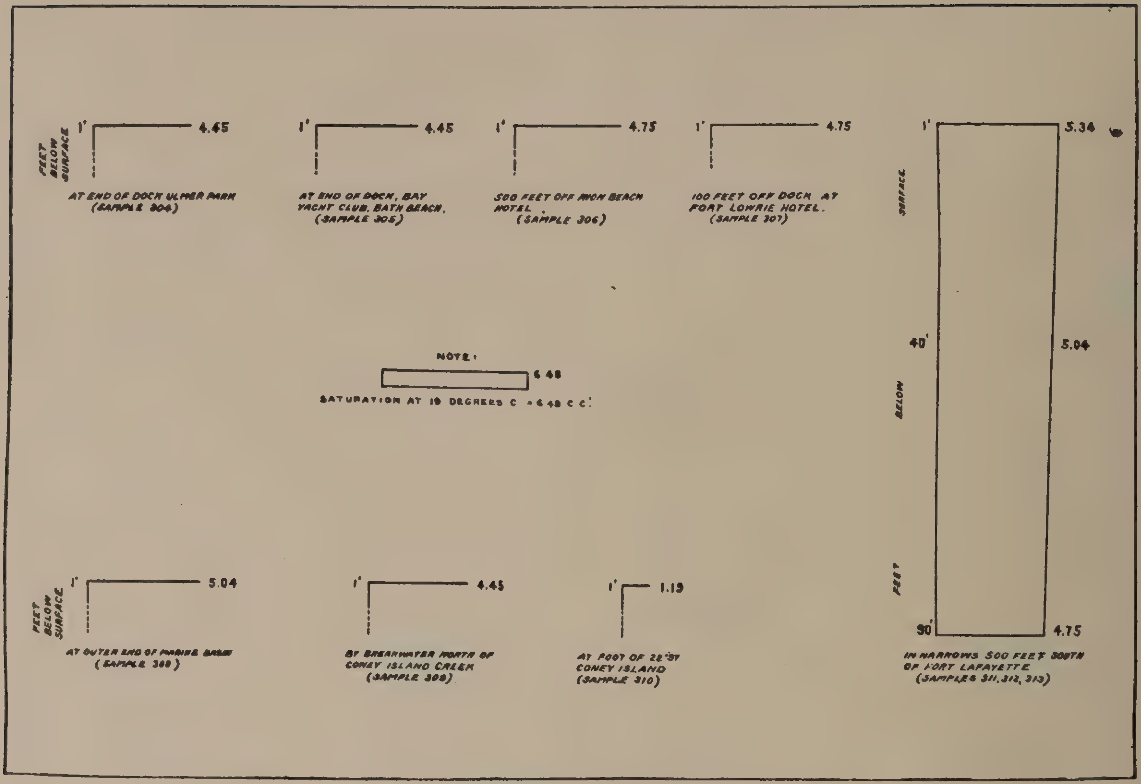
HUDSON RIVER – FROM SPUYTEN DUYVIL TO YONKERS
DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE – RESULTS IN C.C. PER LITRE
SAMPLES COLLECTED JULY 7TH 1909

FIG. 106



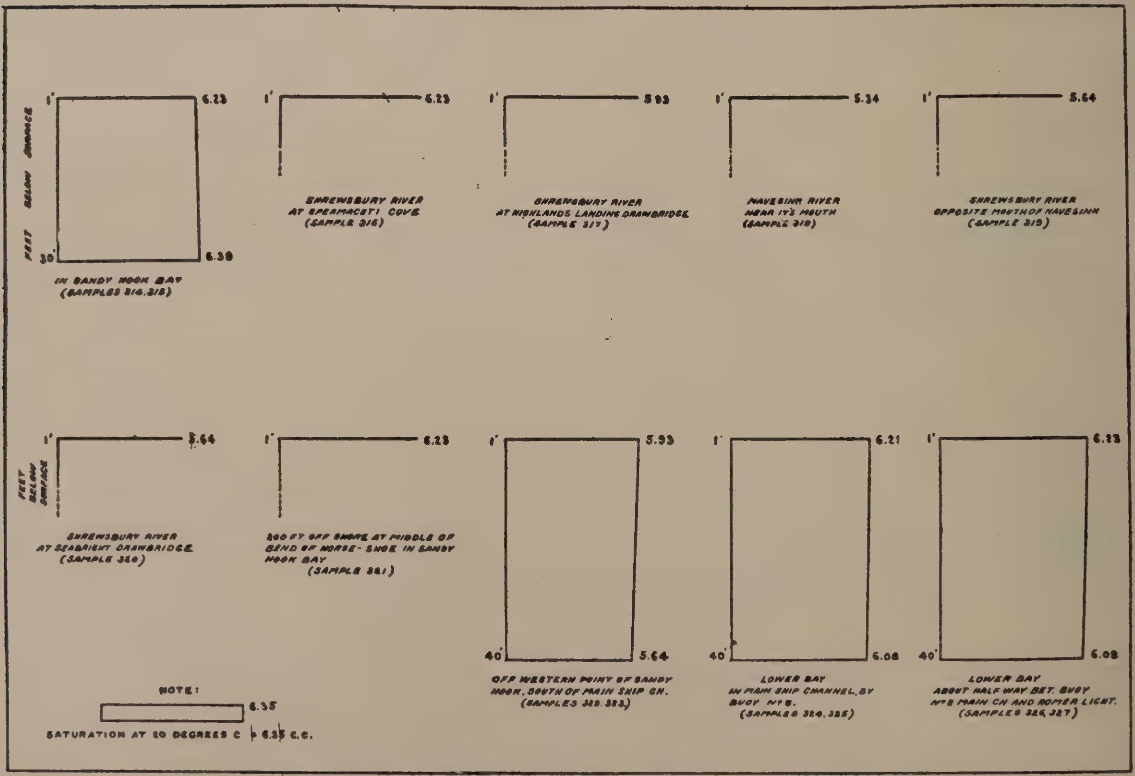
GRAVESEND BAY AND CONEY ISLAND CREEK
DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE – RESULTS IN C.C. PER LITRE
SAMPLES COLLECTED JULY 9TH 1909

FIG. 107



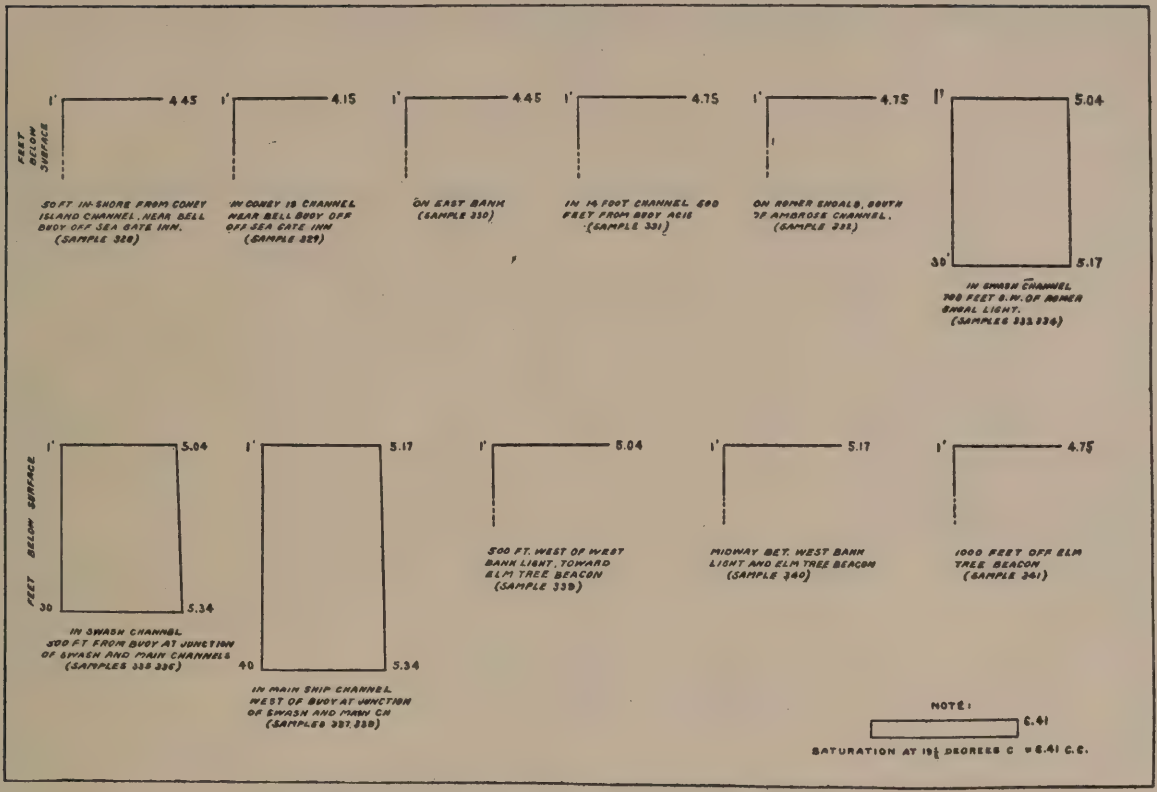
IN GRAVESEND BAY AND NARROWS
DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C C PER LITRE
SAMPLES COLLECTED JULY 10TH 1909

FIG. 108



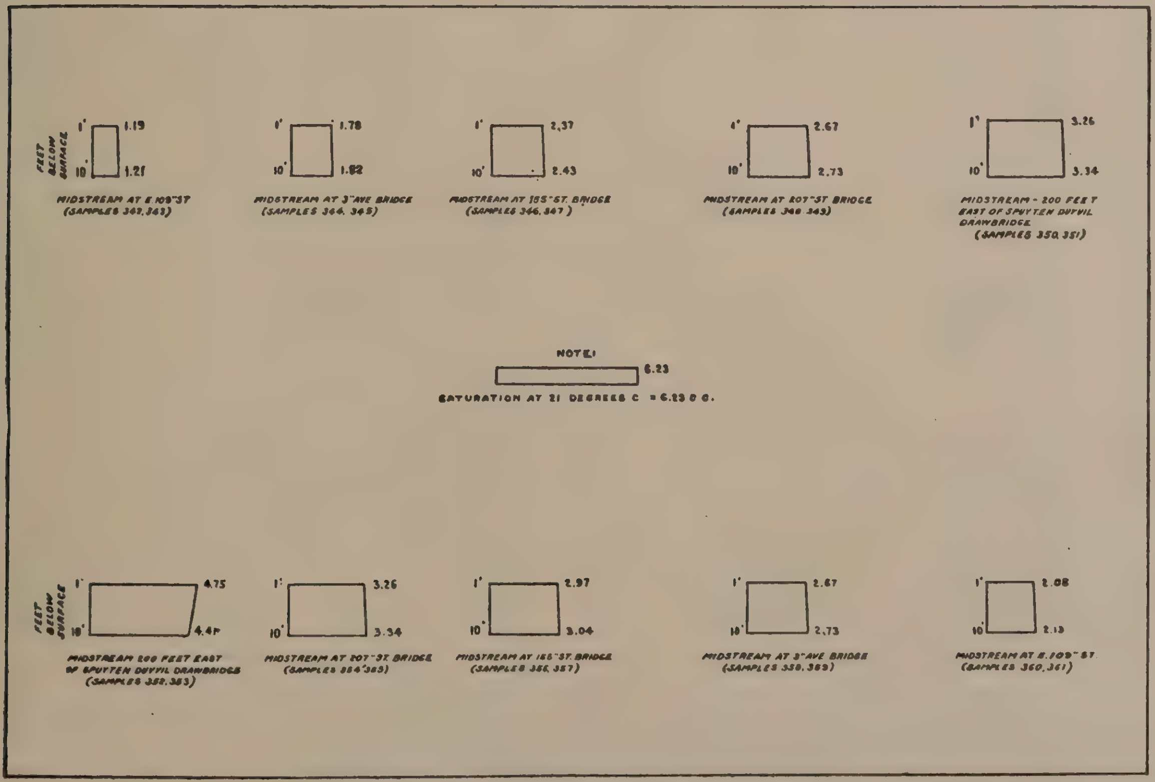
SANDY HOOK BAY - SHREWSBURY RIVER - AND LOWER N.Y. BAY
DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C. PER LITRE
SAMPLES COLLECTED JULY 13TH 1909

FIG. 109



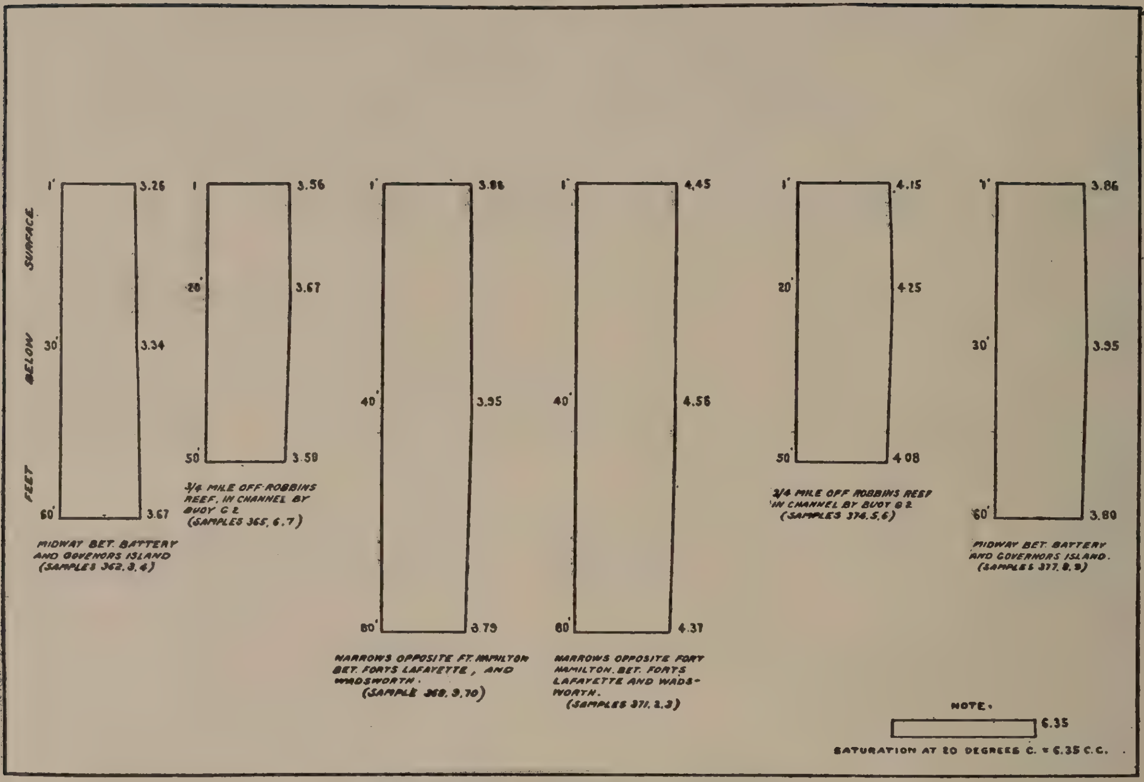
ACROSS LOWER N.Y. BAY – CONEY ISLAND TO ELM TREE BEACON
DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C. PER LITRE
SAMPLES COLLECTED JULY 14TH 1909

FIG. 110



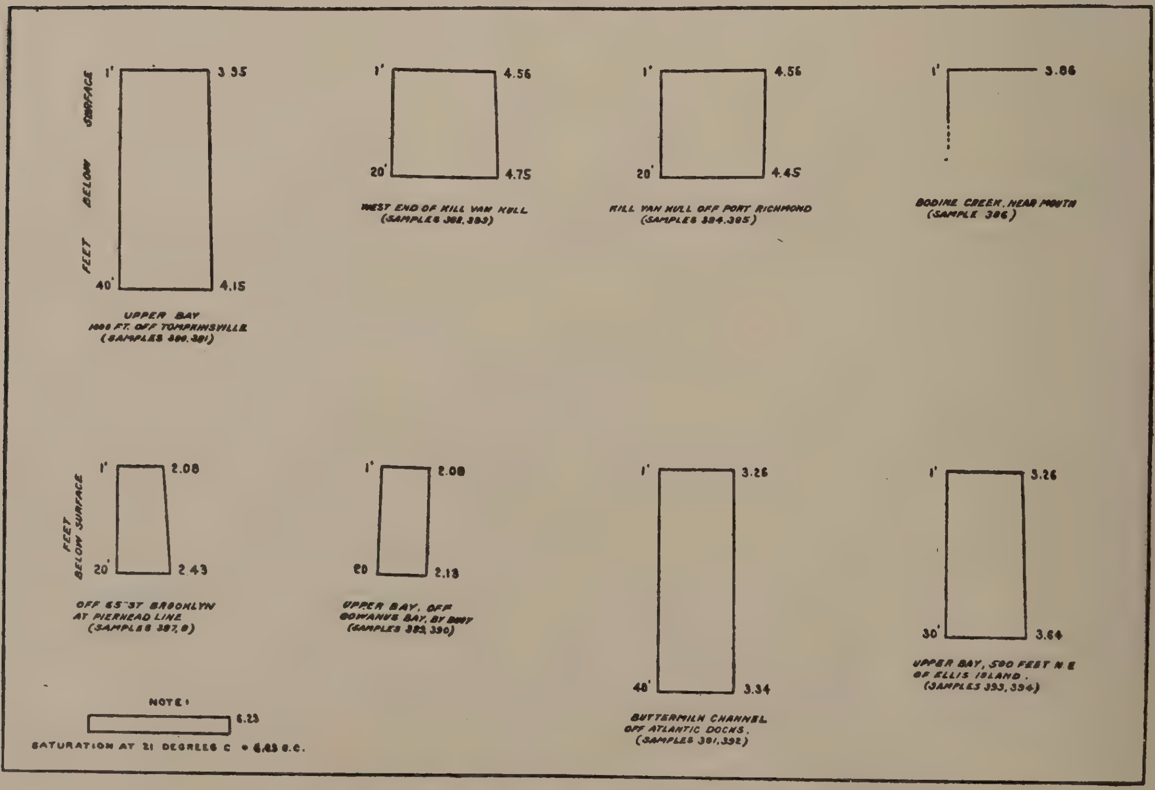
HARLEM RIVER – HELL GATE TO SPUYTEN DUYVIL
DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C. PER LITRE
SAMPLES COLLECTED JULY 15TH 1909

FIG. 111



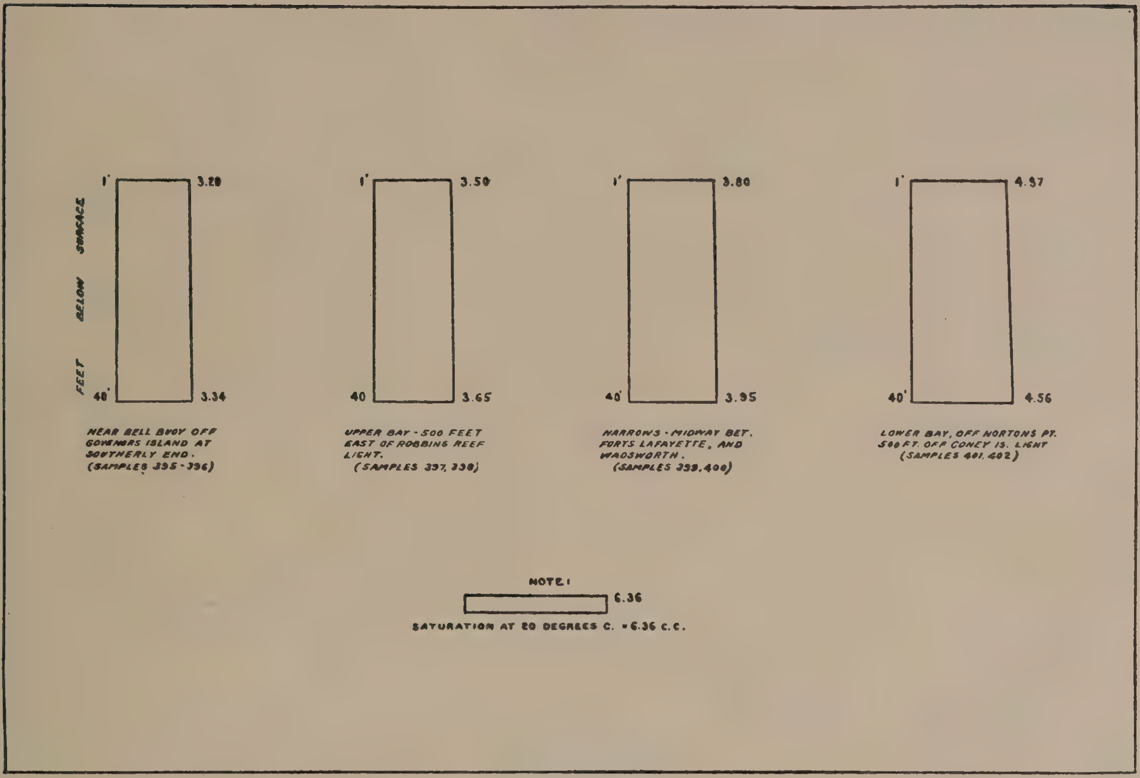
UPPER BAY FROM THE BATTERY TO NARROWS
DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C. PER LITRE
SAMPLES COLLECTED JULY 16TH 1909

FIG. 112



KILL VAN KULL AND EAST SIDE OF UPPER NEW YORK BAY
DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C. PER LITRE
SAMPLES COLLECTED JULY 17TH 1909

FIG. 113

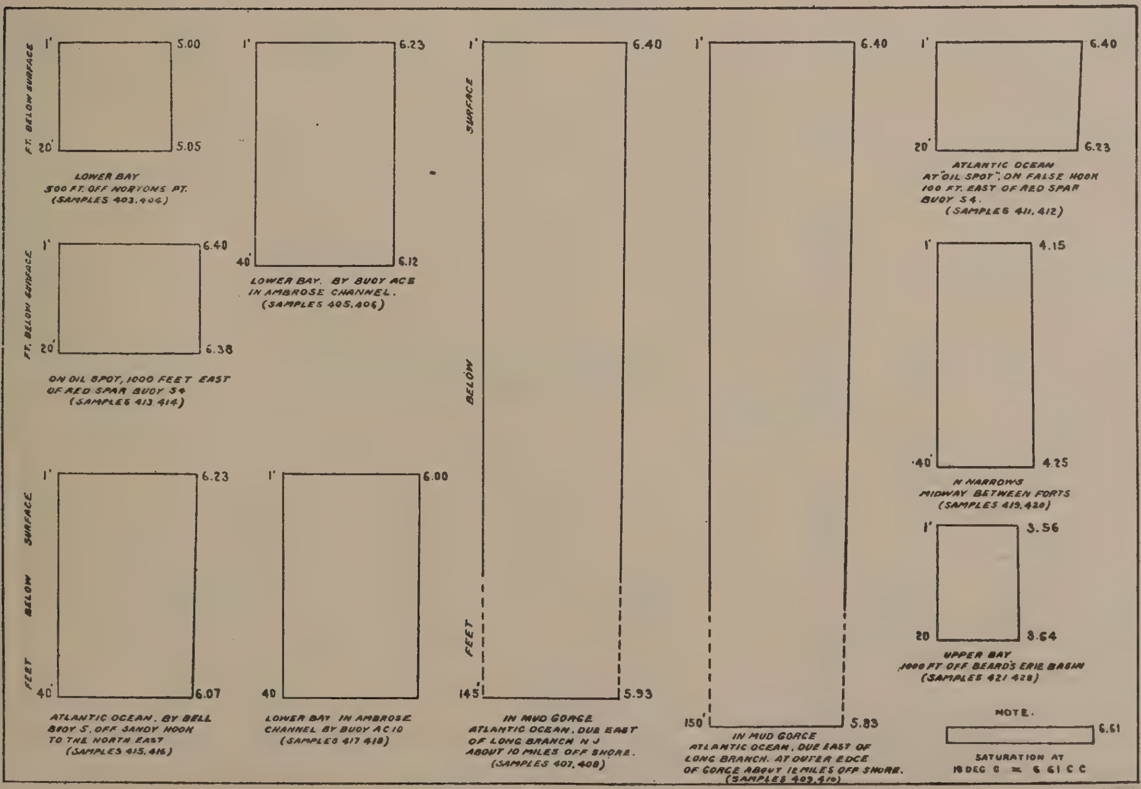


GOVERNORS ISLAND TO CONEY ISLAND

DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C. PER LITRE

SAMPLES COLLECTED JULY 20TH '09

FIG. 114

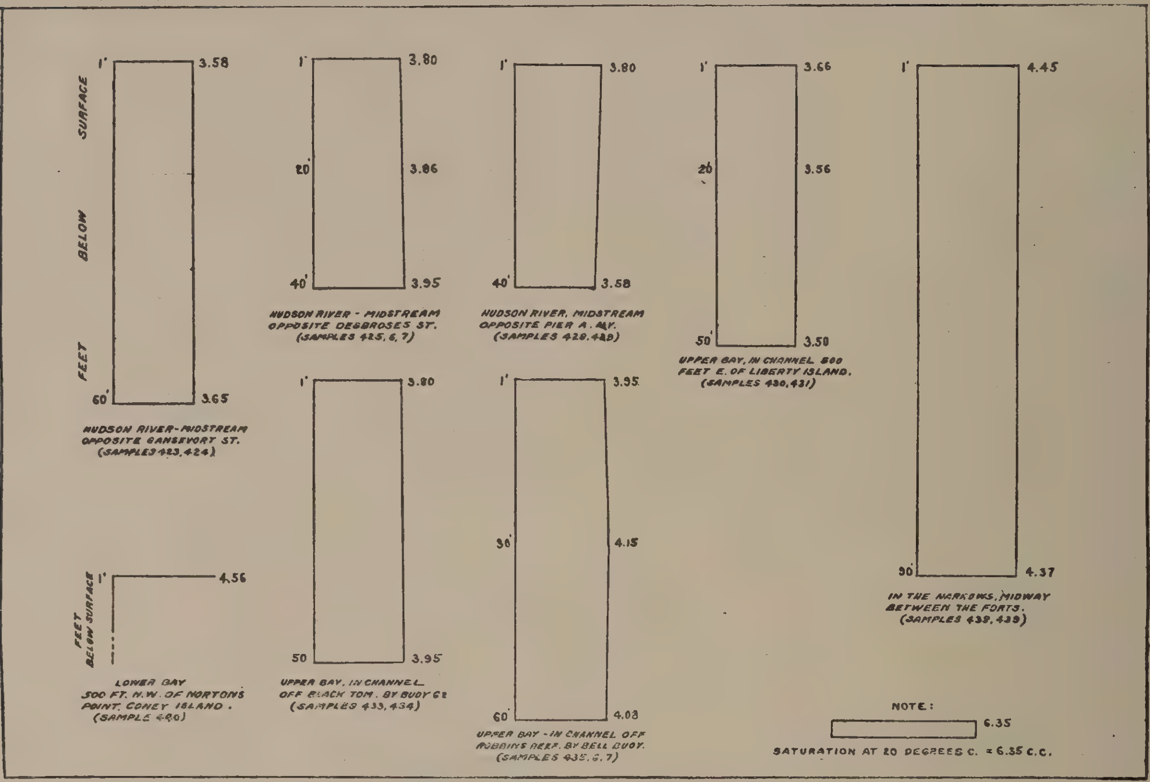


ATLANTIC OCEAN - NEW YORK BAYS

DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C C PER LITRE

SAMPLES COLLECTED JULY 21ST '09

FIG. 115

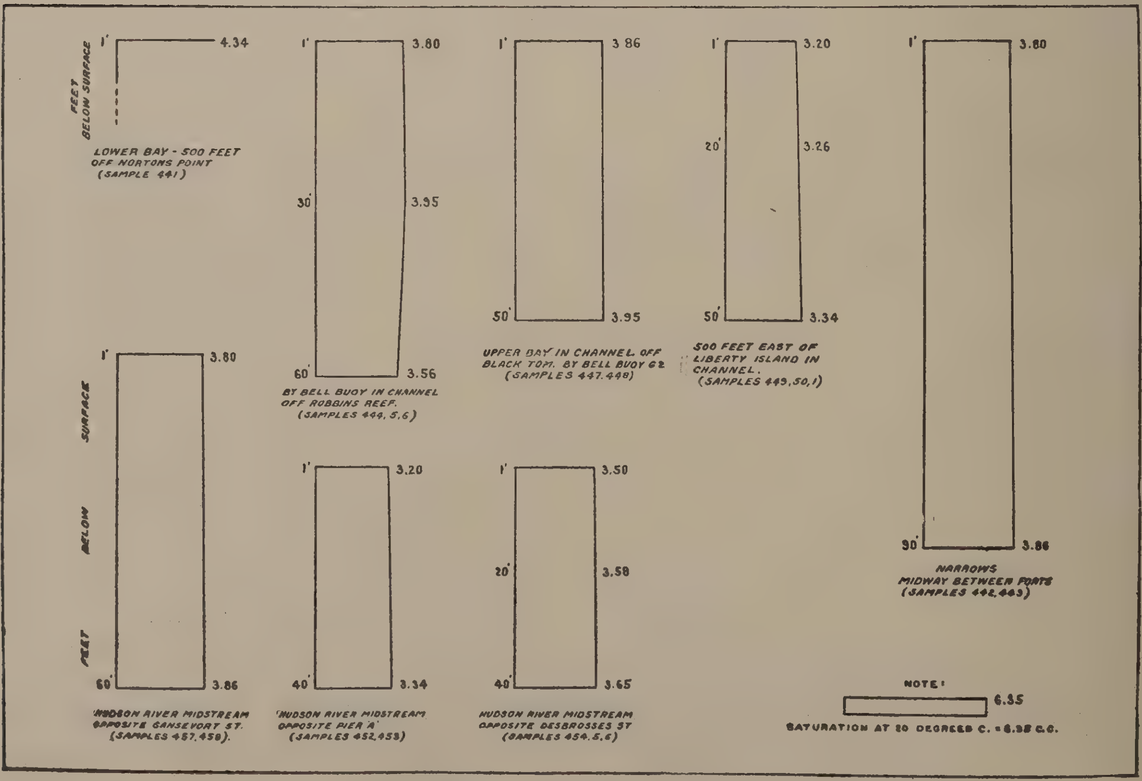


HUDSON RIVER TO CONEY ISLAND

DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C. PER LITRE

SAMPLES COLLECTED JULY 22ND '09

FIG. 116

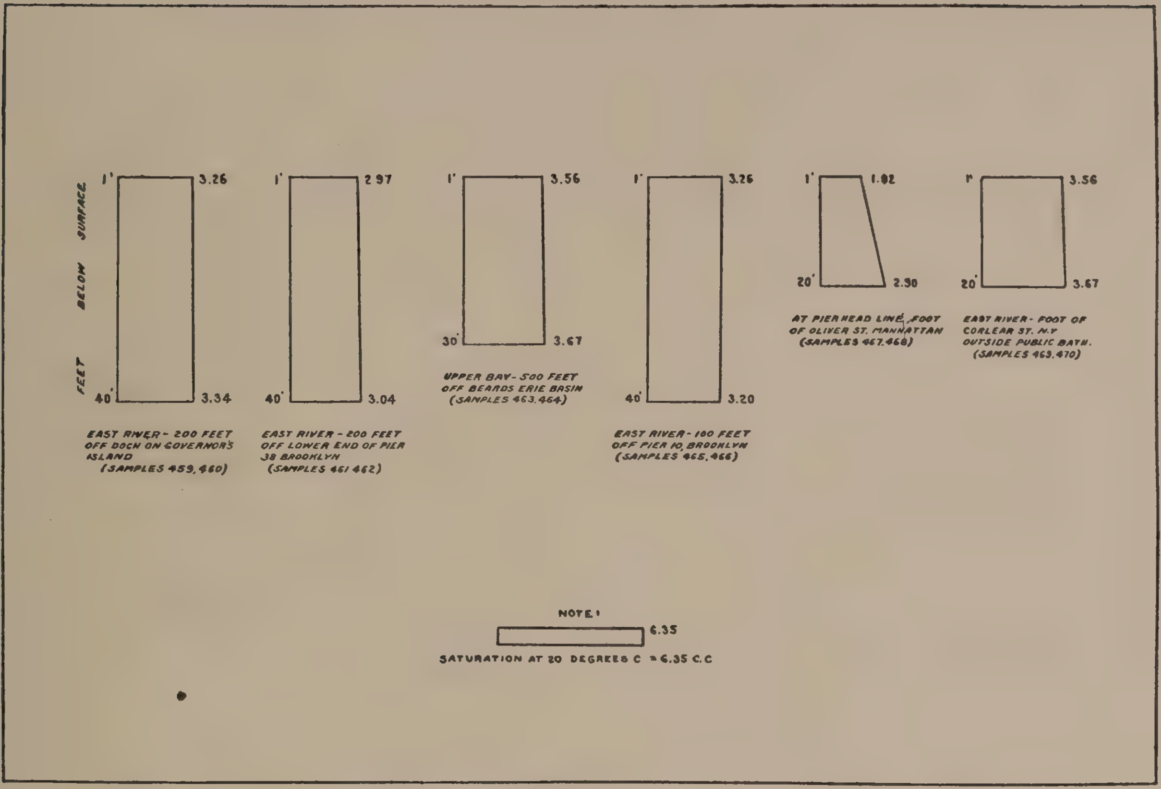


CONEY ISLAND TO HUDSON RIVER

DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C. PER LITRE

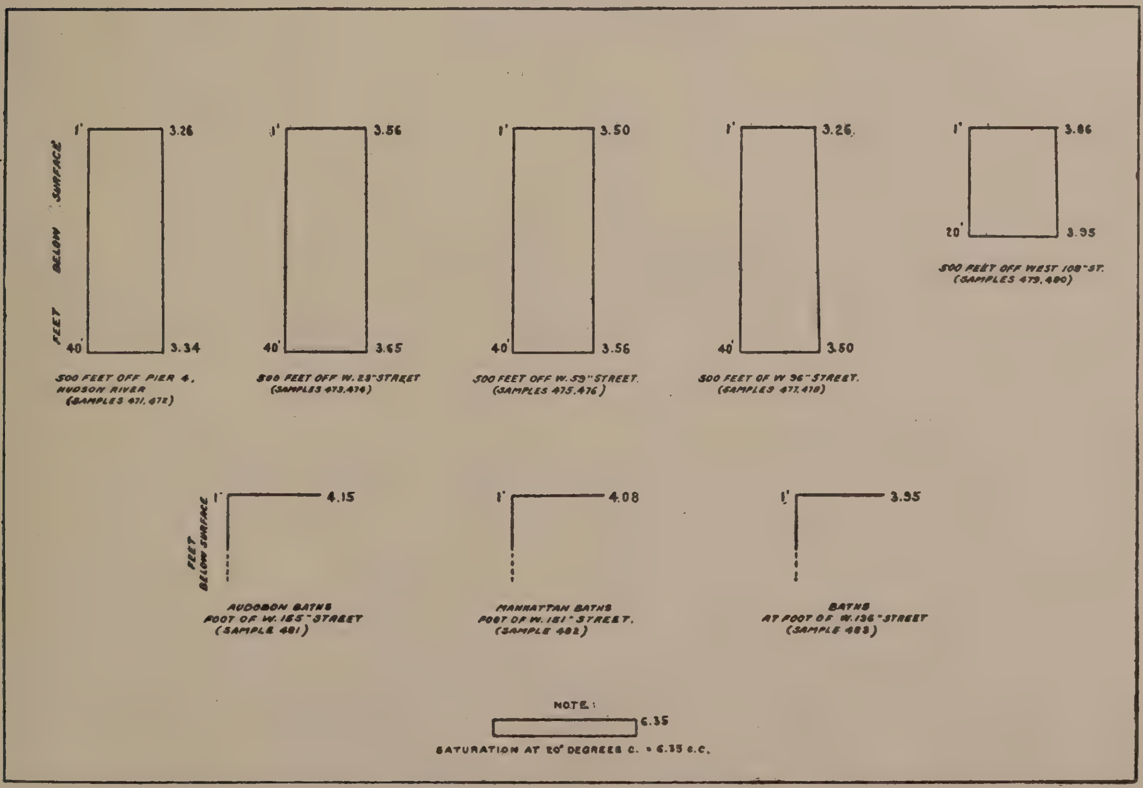
SAMPLES COLLECTED JULY 22ND '09

FIG. 117



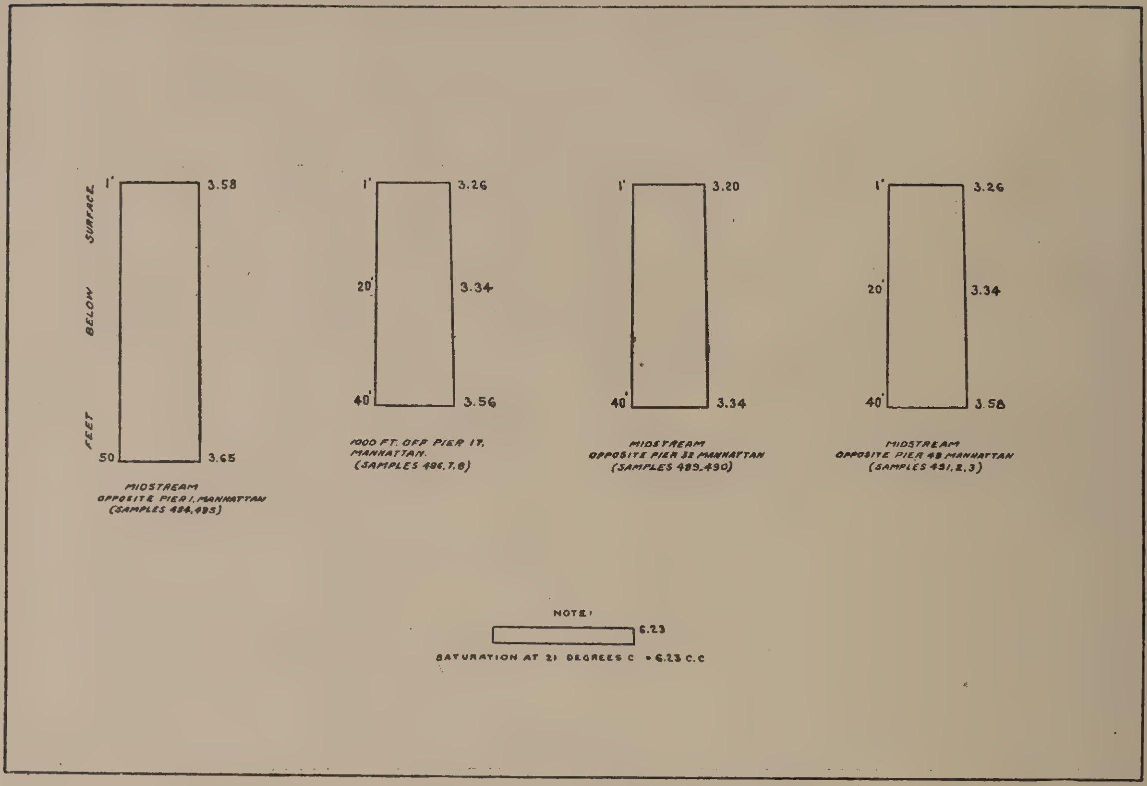
ERIE BASIN TO CORLEARS HOOK - EAST RIVER
DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C. PER LITRE
SAMPLES COLLECTED JULY 24TH '09

FIG. 118



HUDSON RIVER - BATHING BEACHES
DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C PER LITRE
SAMPLES COLLECTED JULY 26TH 1909

FIG. 119

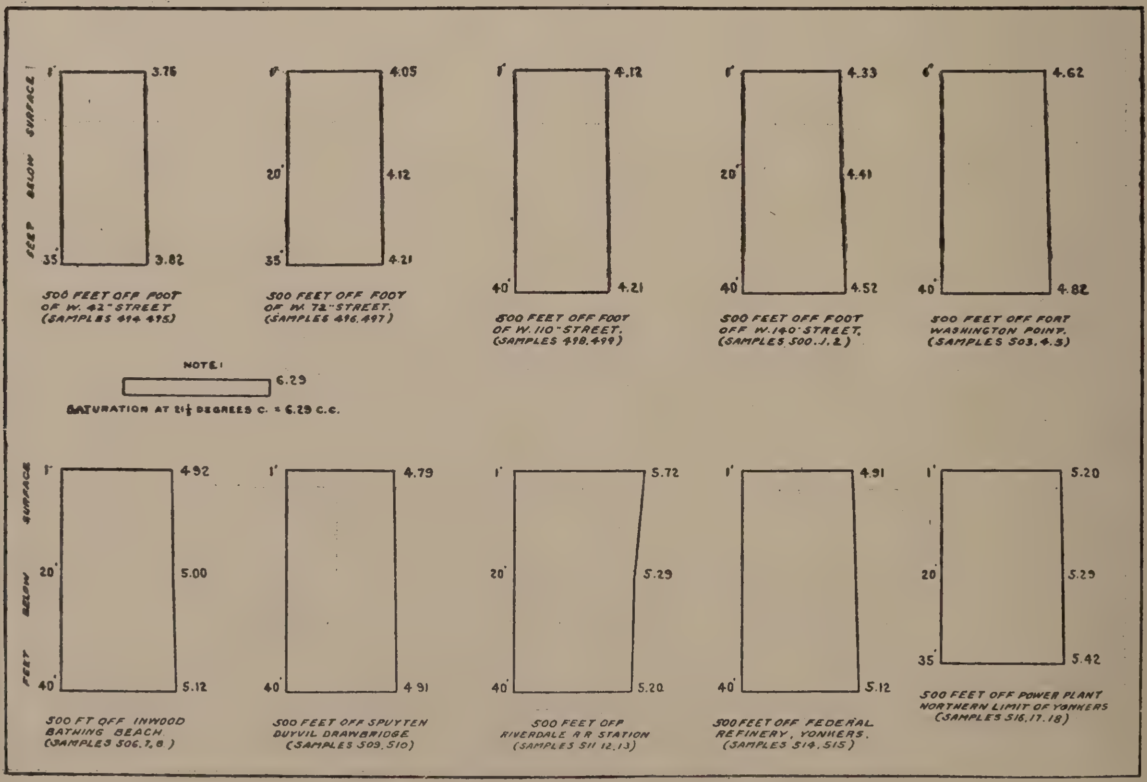


HUDSON RIVER – NEAR MOUTH

DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE – RESULTS IN C.C. PER LITRE

SAMPLES COLLECTED AUG. 19TH 1909

FIG. 120

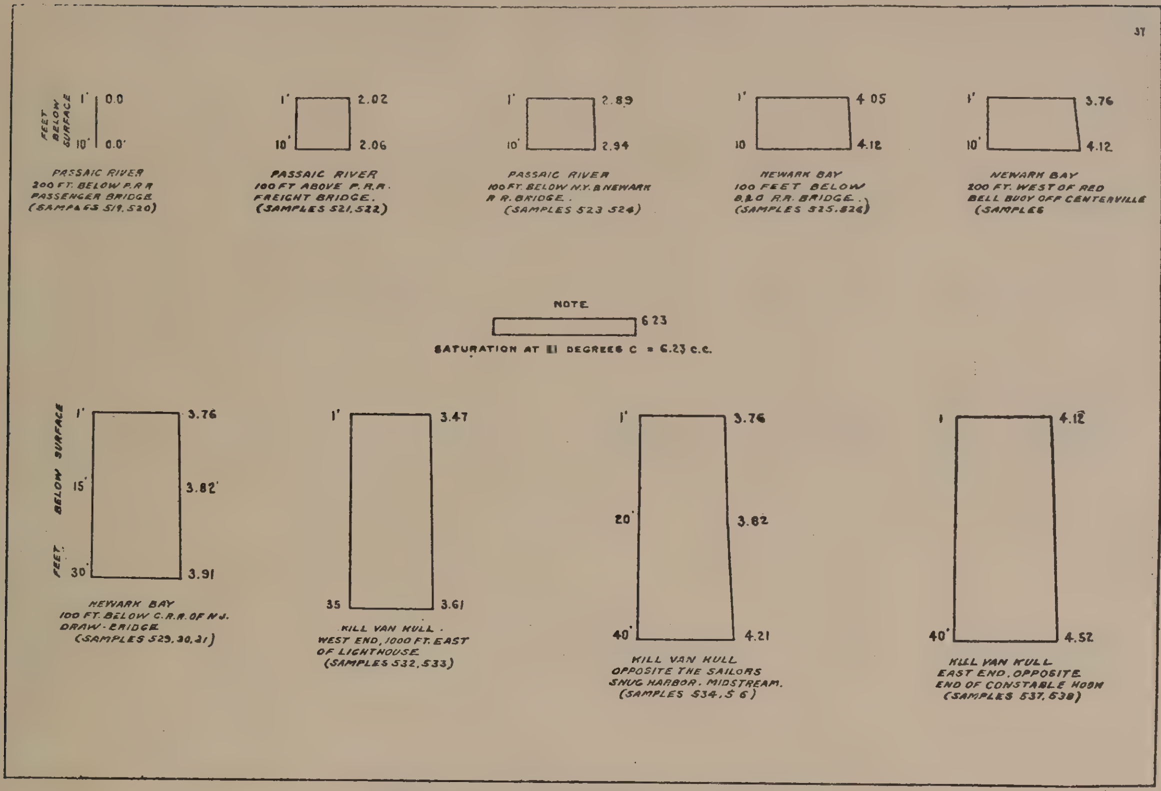


HUDSON RIVER FROM E 42ND ST TO YONKERS

DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE – RESULTS IN C.C. PER LITRE

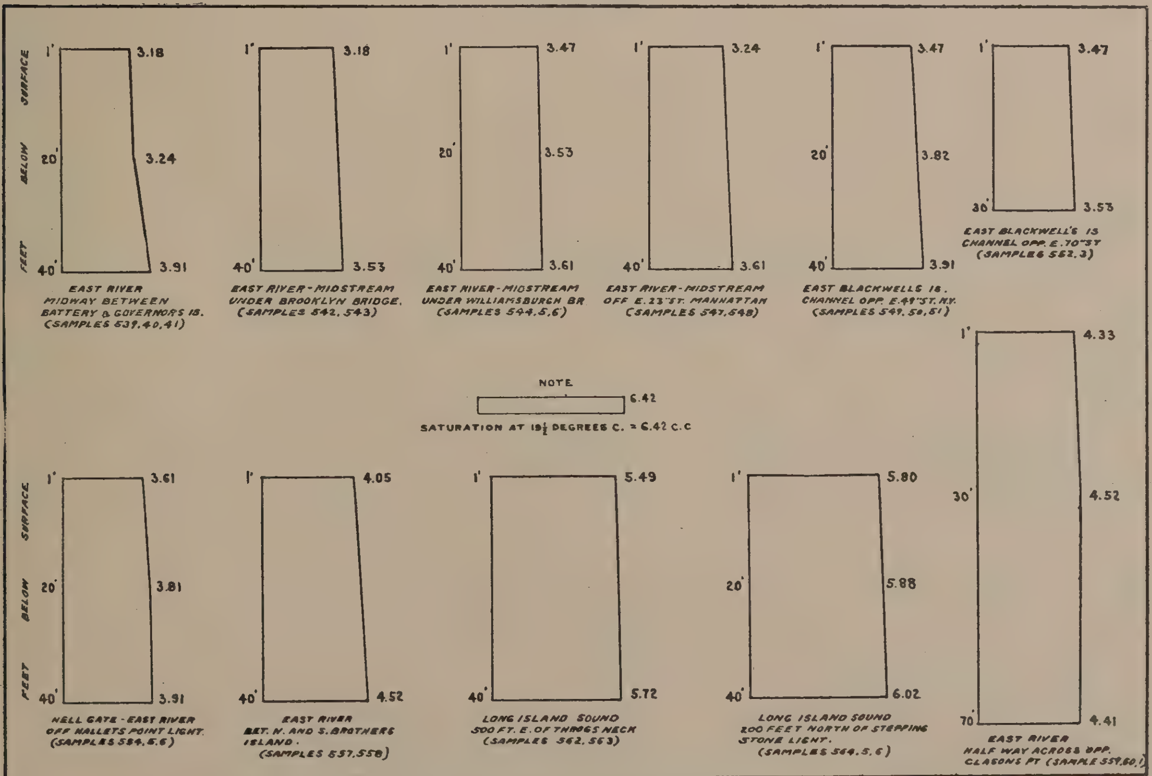
SAMPLES COLLECTED SEPT. 7TH 1909

FIG. 121



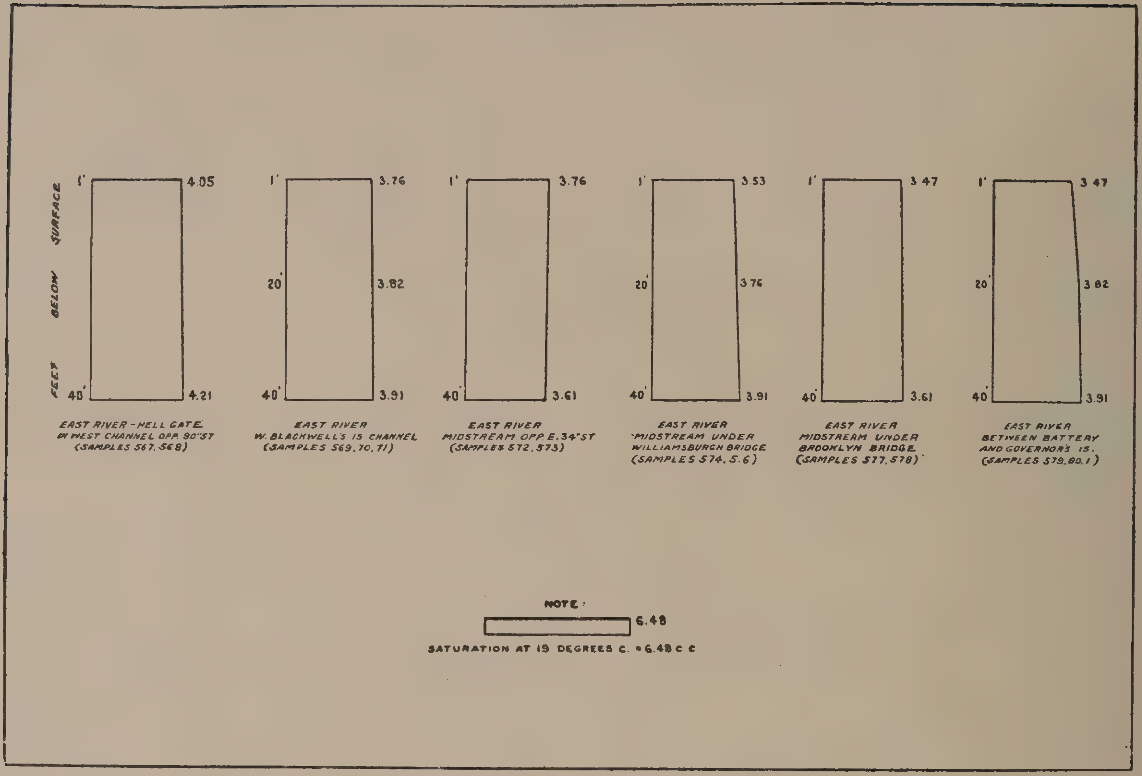
PASSAIC RIVER, NEWARK BAY & KILL VAN KULL
DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C C. PER LITRE
SAMPLES COLLECTED SEPT 8TH 1909

FIG. 122



EAST RIVER FROM BATTERY TO STEPPING STONE LIGHT, L I SOUND
DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C. PER LITRE
SAMPLES COLLECTED SEPT. 9TH 1909

FIG. 123

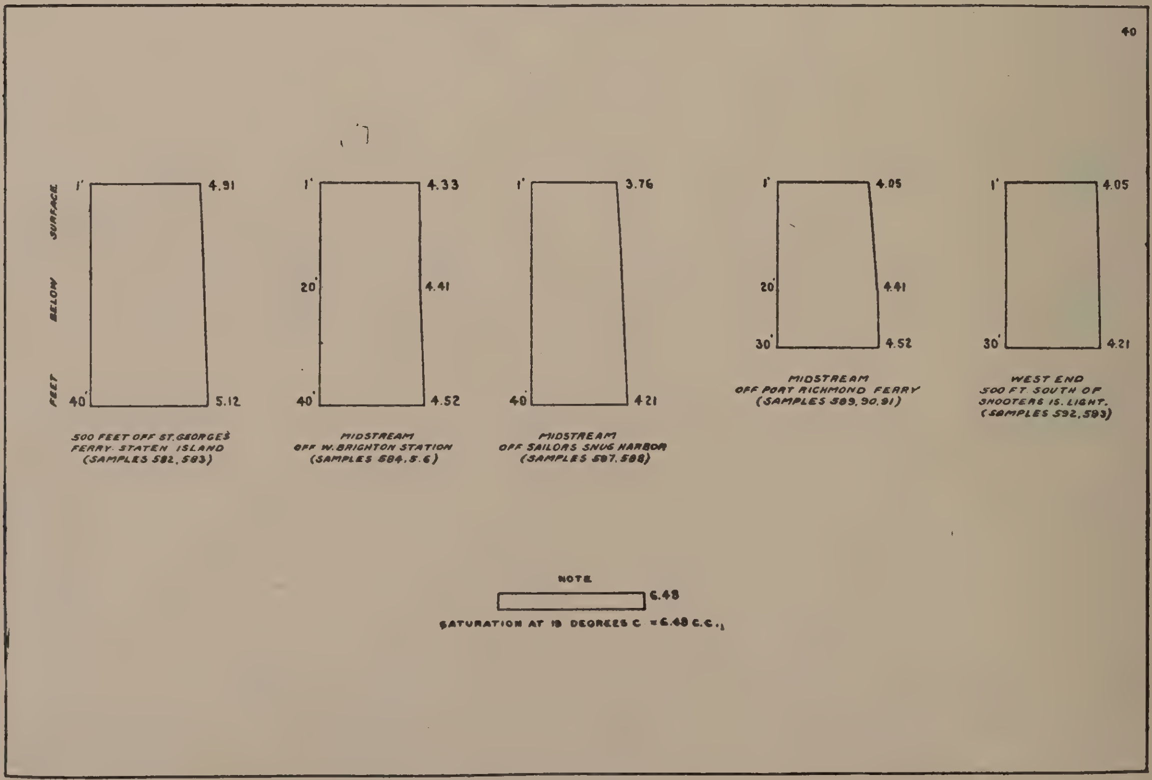


EAST RIVER FROM HELL GATE TO BATTERY

DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C. PER LITRE

SAMPLES COLLECTED SEPT. 10TH 1909

FIG. 124

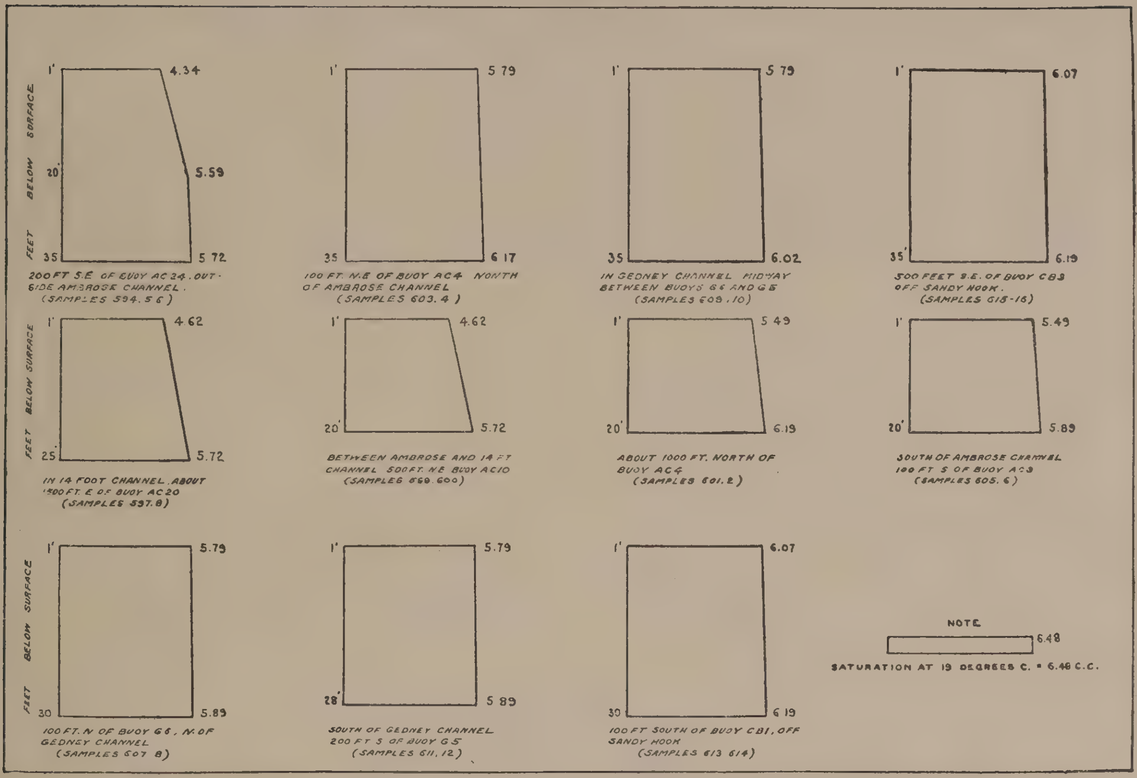


KILL VAN KULL

DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C. PER LITRE

SAMPLES COLLECTED SEPT. 11TH 190'

FIG. 125

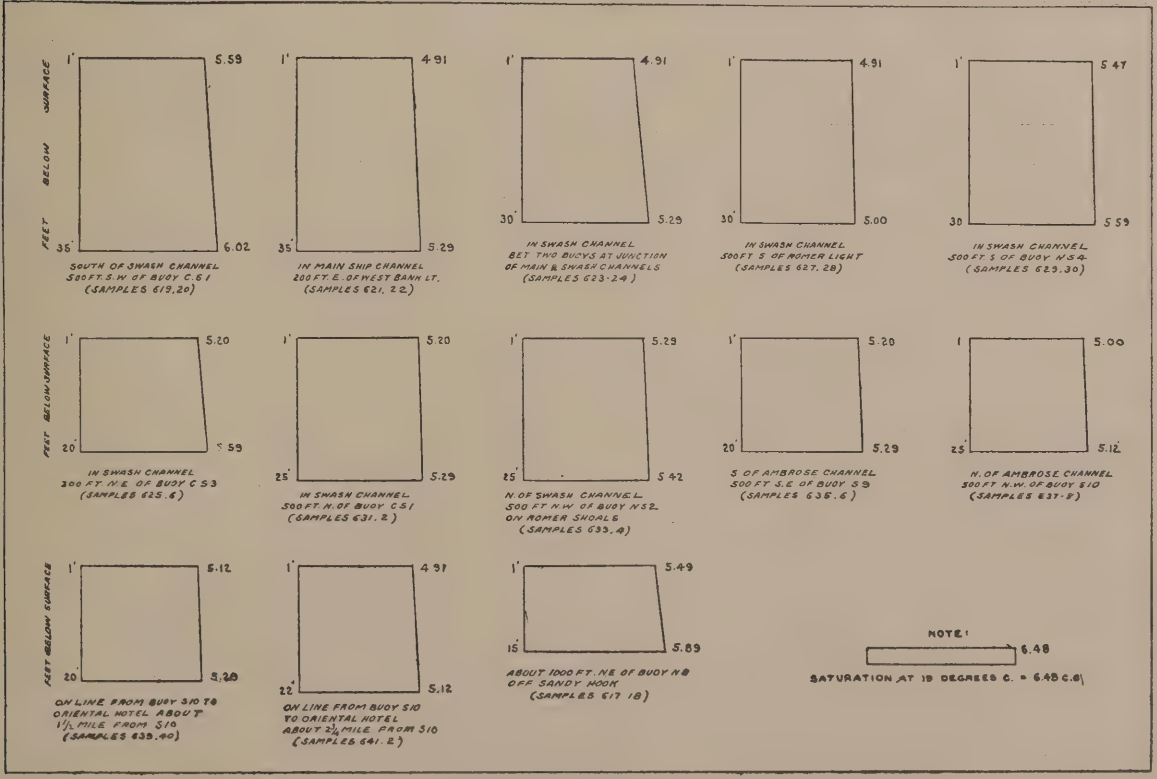


LOWER BAY

DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C PER LITRE

SAMPLES COLLECTED SEPT. 13TH 1909

FIG. 126

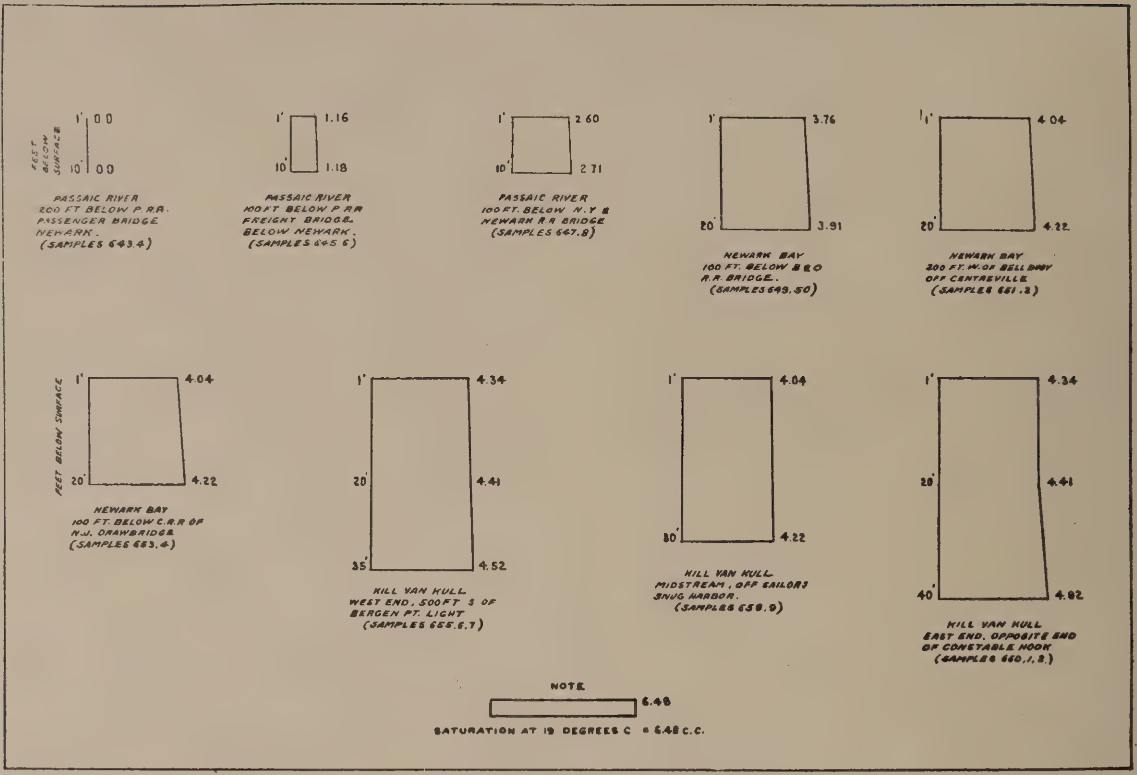


LOWER BAY IN SWASH CHANNEL ETC

DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C. PER LITRE

SAMPLES COLLECTED SEPT. 13TH & 14TH 1909

FIG. 127

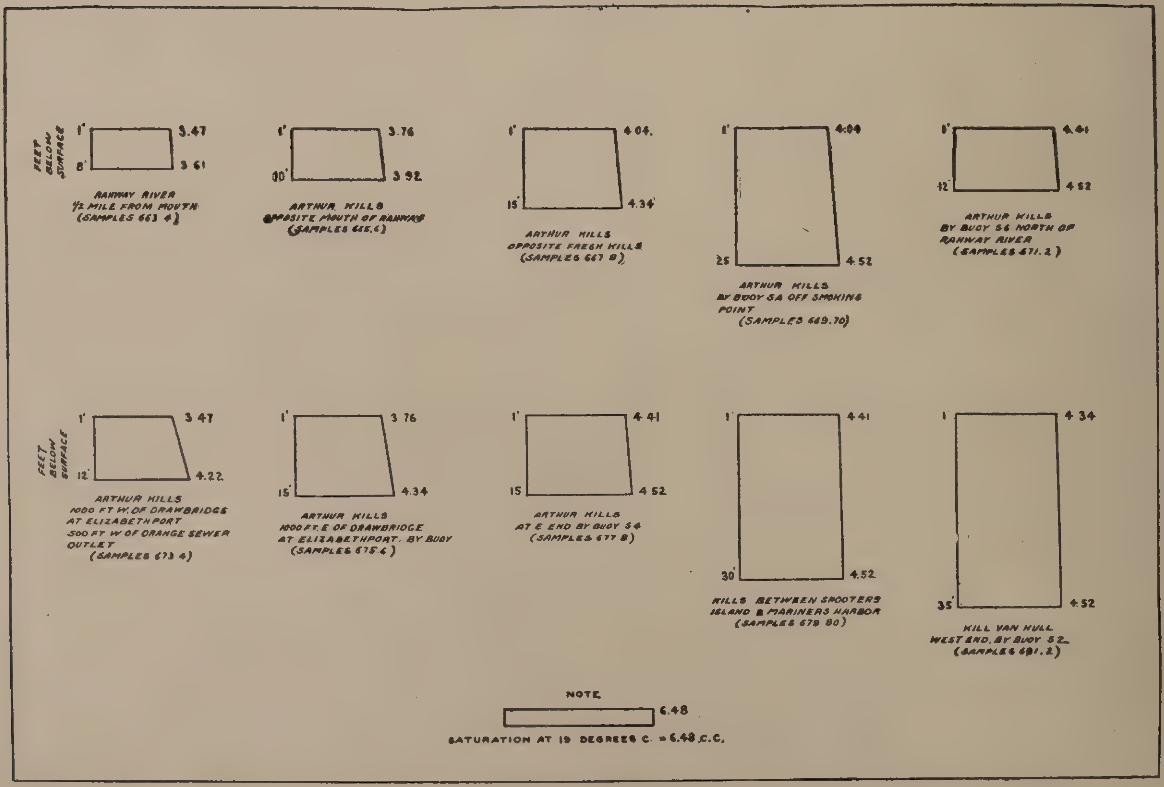


NEWARK BAY, PASSAIC RIVER, KILL VAN KULL

DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE – RESULTS IN C.C. PER LITRE

SAMPLES COLLECTED SEPT. 15TH 1909

FIG. 128

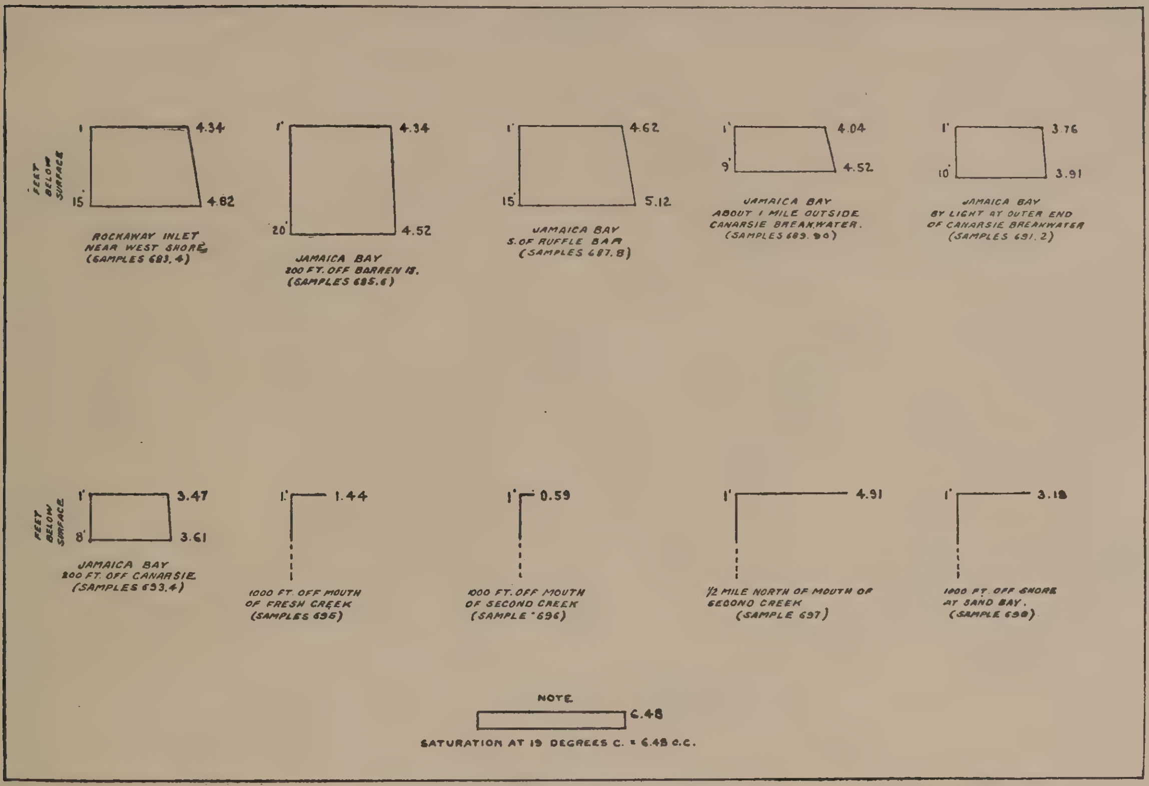


ARTHUR KILLS

DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE – RESULTS IN C.C PER LITRE

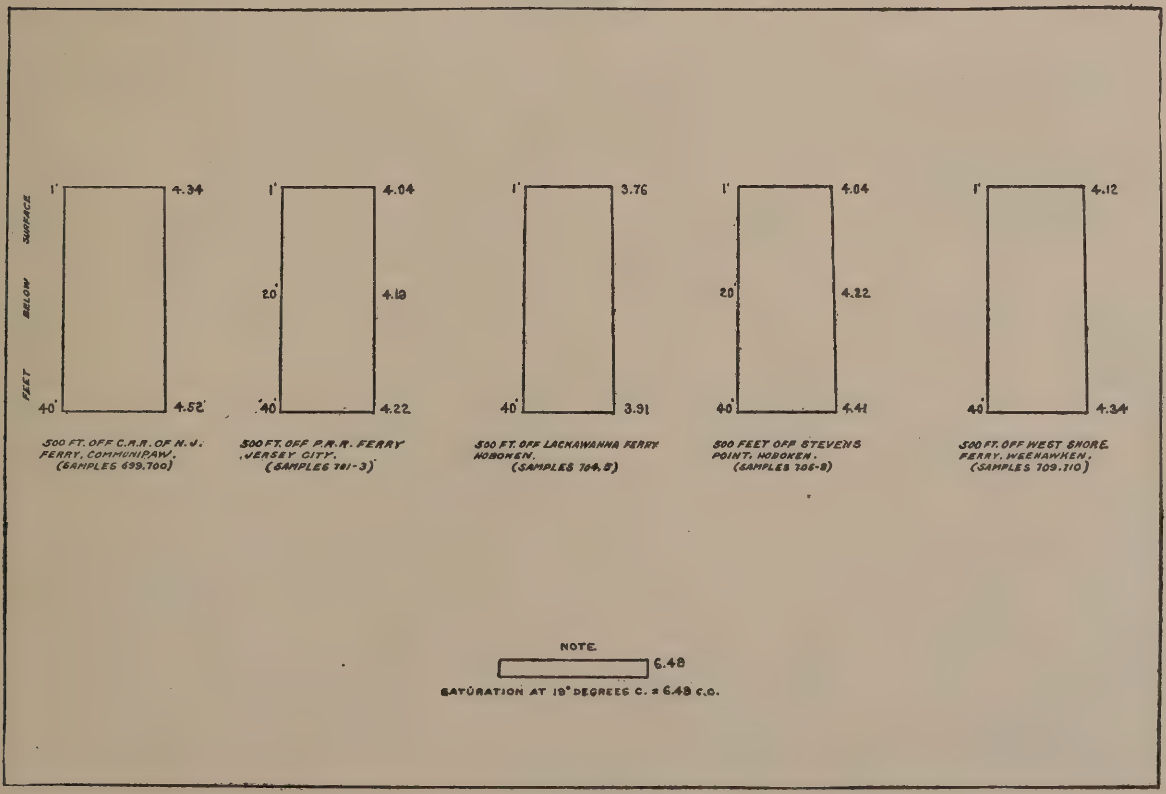
SAMPLES COLLECTED SEPT 16TH 1909

FIG. 129



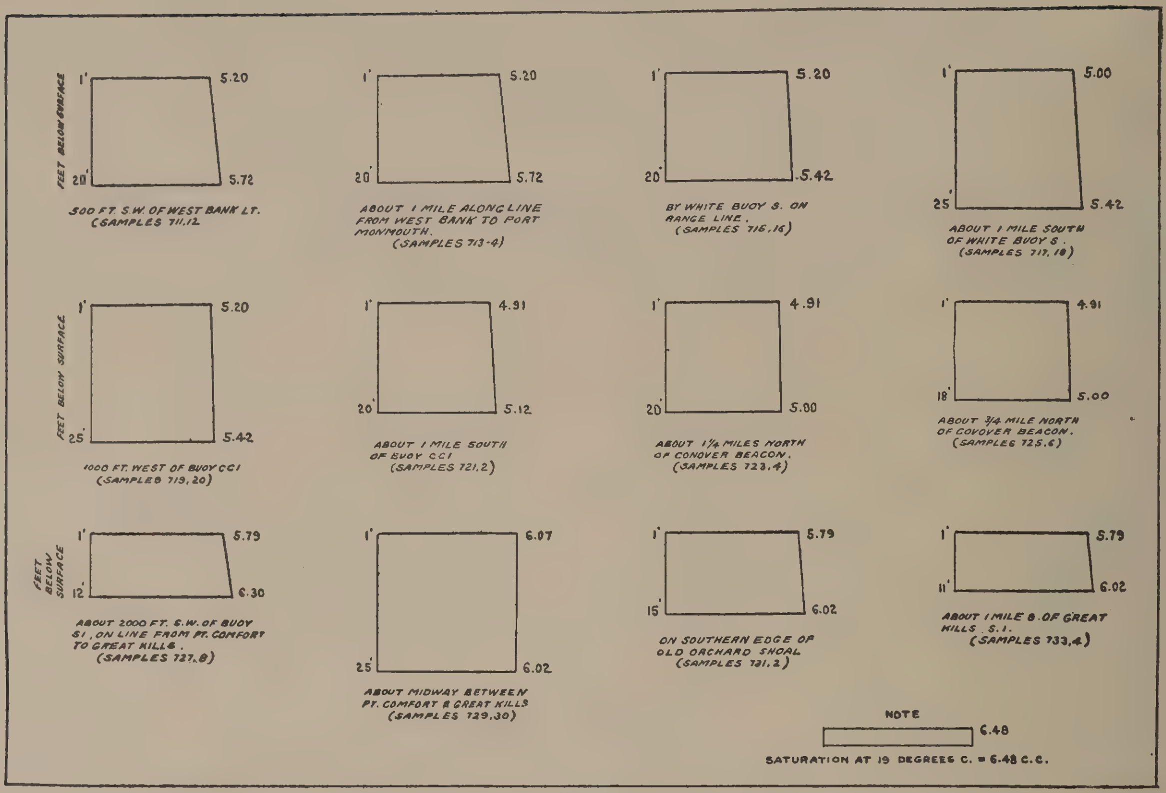
JAMAICA BAY, INLET, SECOND CREEK
DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C. PER LITRE
SAMPLES COLLECTED SEPT 17TH 1909

FIG. 130



HUDSON RIVER - JERSEY SHORE
DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C. PER LITRE
SAMPLES COLLECTED SEPT. 18TH 1909

FIG. 131

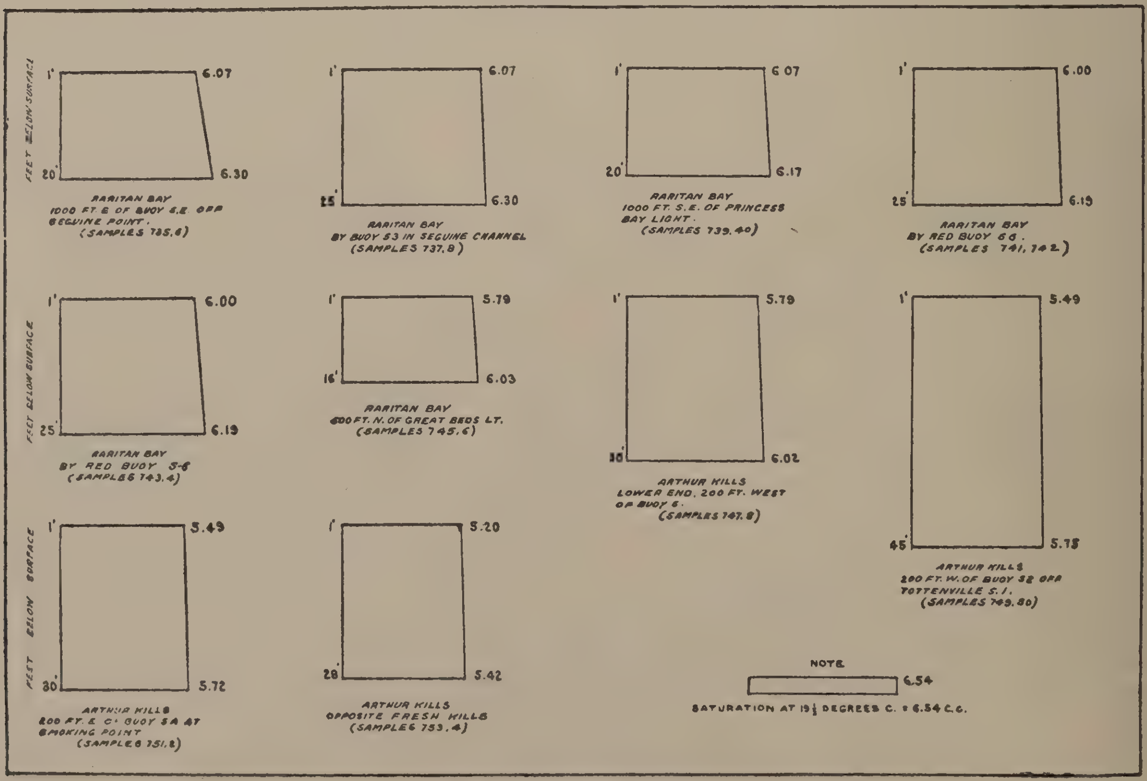


LOWER BAY

DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C. PER LITRE

SAMPLES COLLECTED SEPT 21ST 1909

FIG. 132

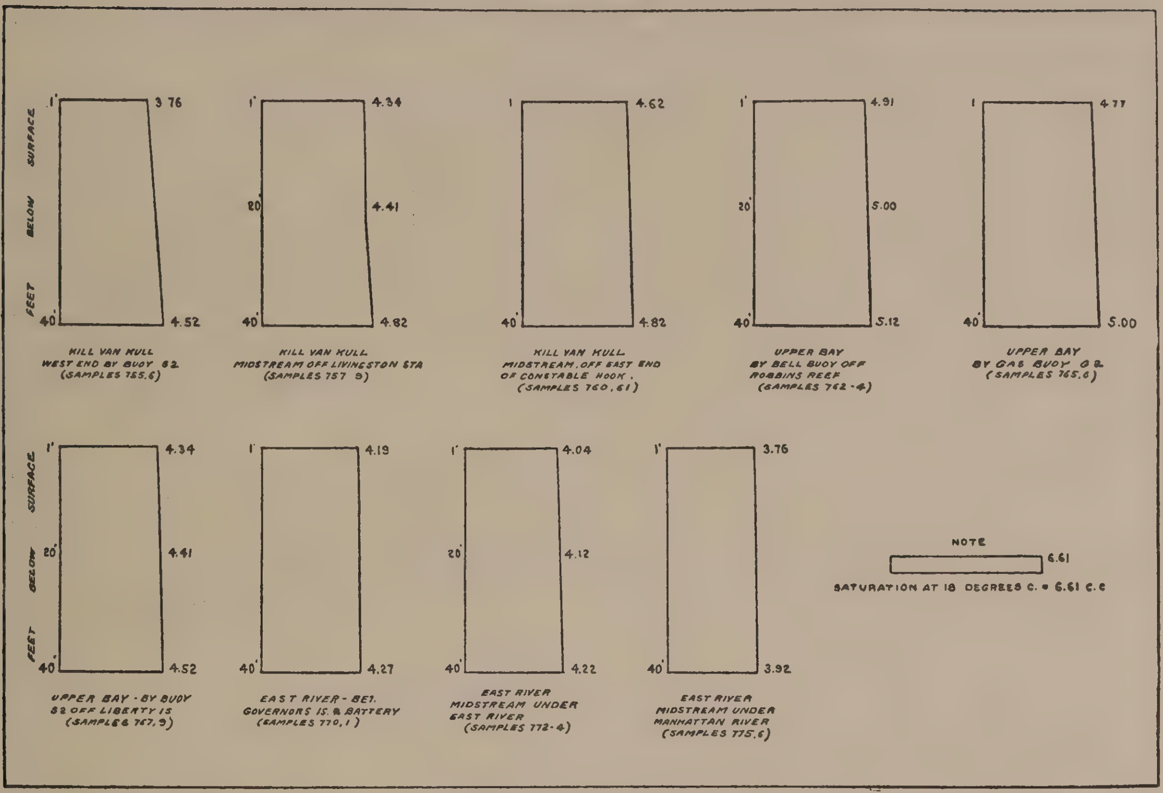


RARITAN BAY · ARTHUR KILLS

DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C. PER LITRE

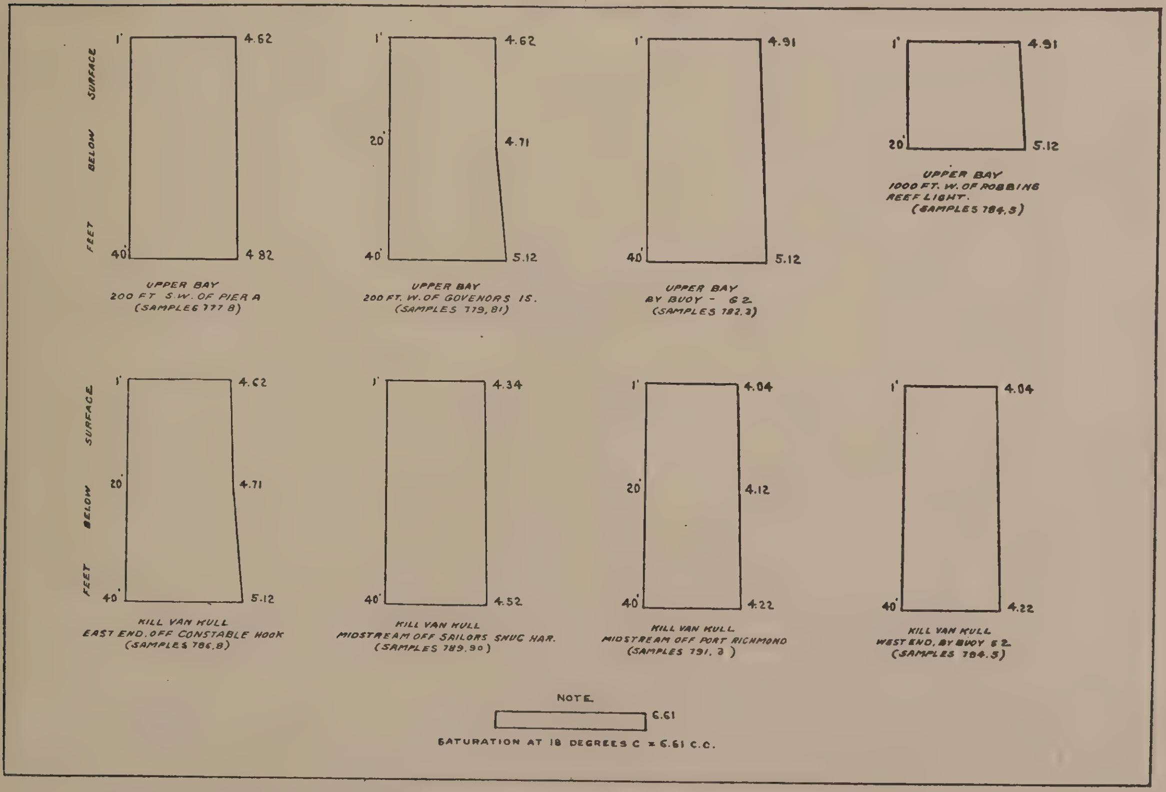
SAMPLES COLLECTED SEPT. 21ST 1909

FIG. 133



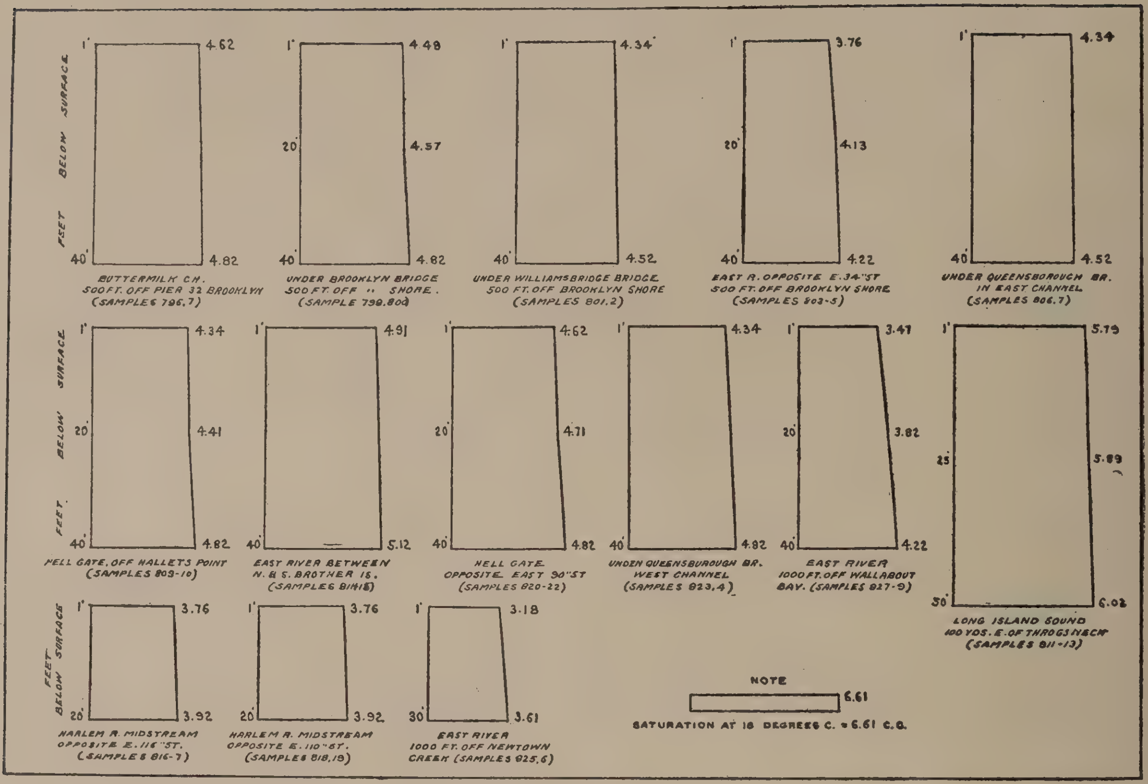
KILL VAN KULL, UPPER BAY, EAST RIVER
DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C. PER LITRE
SAMPLES COLLECTED SEPT. 23RD 1909

FIG. 134



UPPER BAY - KILL VAN KULL
DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C. PER LITRE
SAMPLES COLLECTED SEPT. 30TH 1909

FIG. 135

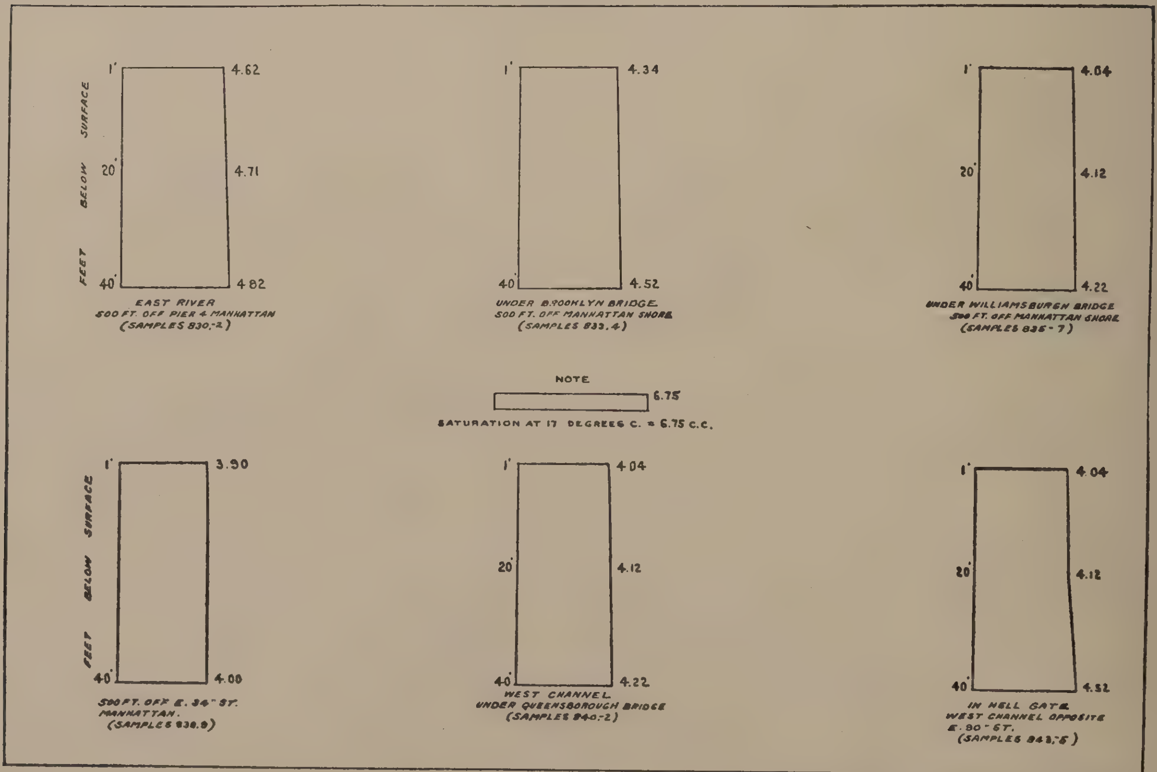


EAST RIVER - LONG IS. SOUND

DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C. PER LITRE

SAMPLES COLLECTED OCT. 1ST 1909

FIG. 136

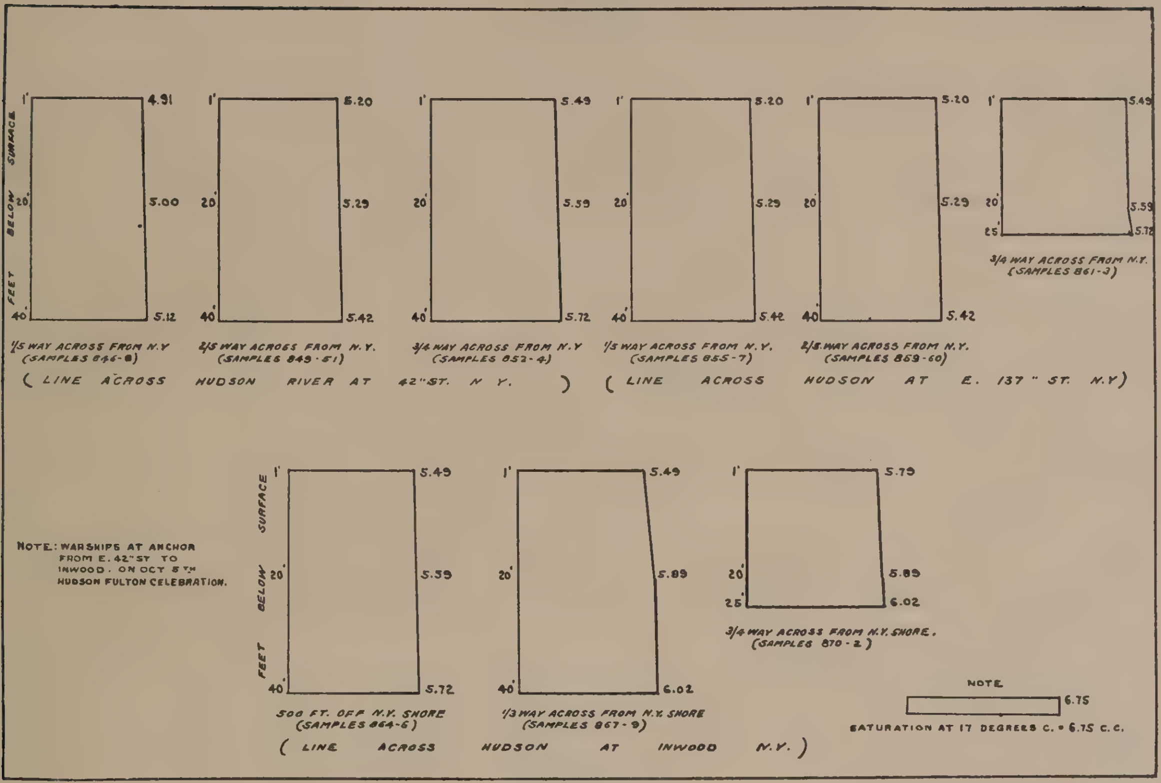


EAST RIVER

DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE - RESULTS IN C.C. PER LITRE

SAMPLES COLLECTED OCT. 2ND 1909

FIG. 137



HUDSON RIVER

DISSOLVED OXYGEN IN WATER AT DIFFERENT DEPTHS BELOW SURFACE – RESULTS IN C.C. PER LITRE

SAMPLES COLLECTED OCT. 5TH 1909

INTRODUCTION TO OXYGEN DIAGRAMS II

From the data contained in Table XXVII curves have been drawn to show the variations in oxygen which occurred in one tidal cycle in the cross-sections of the Narrows, the Hudson river at the mouth and at Mt. St. Vincent and the East river at the mouth and at Throgs Neck, in the year 1911.

EXPLANATION OF THE OXYGEN CURVES

Two groups of curves have been drawn for each section. In one the ordinates represent the percentages of saturation of dissolved oxygen in the water and the percentages of sea-water and the abscissæ the hours of the day. Times of ebb and flood currents are indicated on the curves. Curves have been drawn for each of the three or five locations at which samples were collected in the cross-section, the full lines representing percentages of saturation of dissolved oxygen and the broken lines percentages of sea-water. Light lines show percentages at 1 foot below the surface and heavy lines percentages at mid depth and bottom, the latter being identical, or nearly so, in most cases.

LINES OF EQUAL OXYGEN AND EQUAL SALINITY

In addition to the foregoing, curves have been drawn to show the variations in dissolved oxygen and percentage of sea-water at each cross-section, as determined by each set of samples. These curves approximately indicate lines of equal oxygen and sea-water. The points from which the samples were collected are indicated upon the cross-section of the stream.

OXYGEN DIAGRAMS II.

Variations during a tidal cycle in dissolved oxygen in the water through cross-sections of tidal channels in the year 1911.

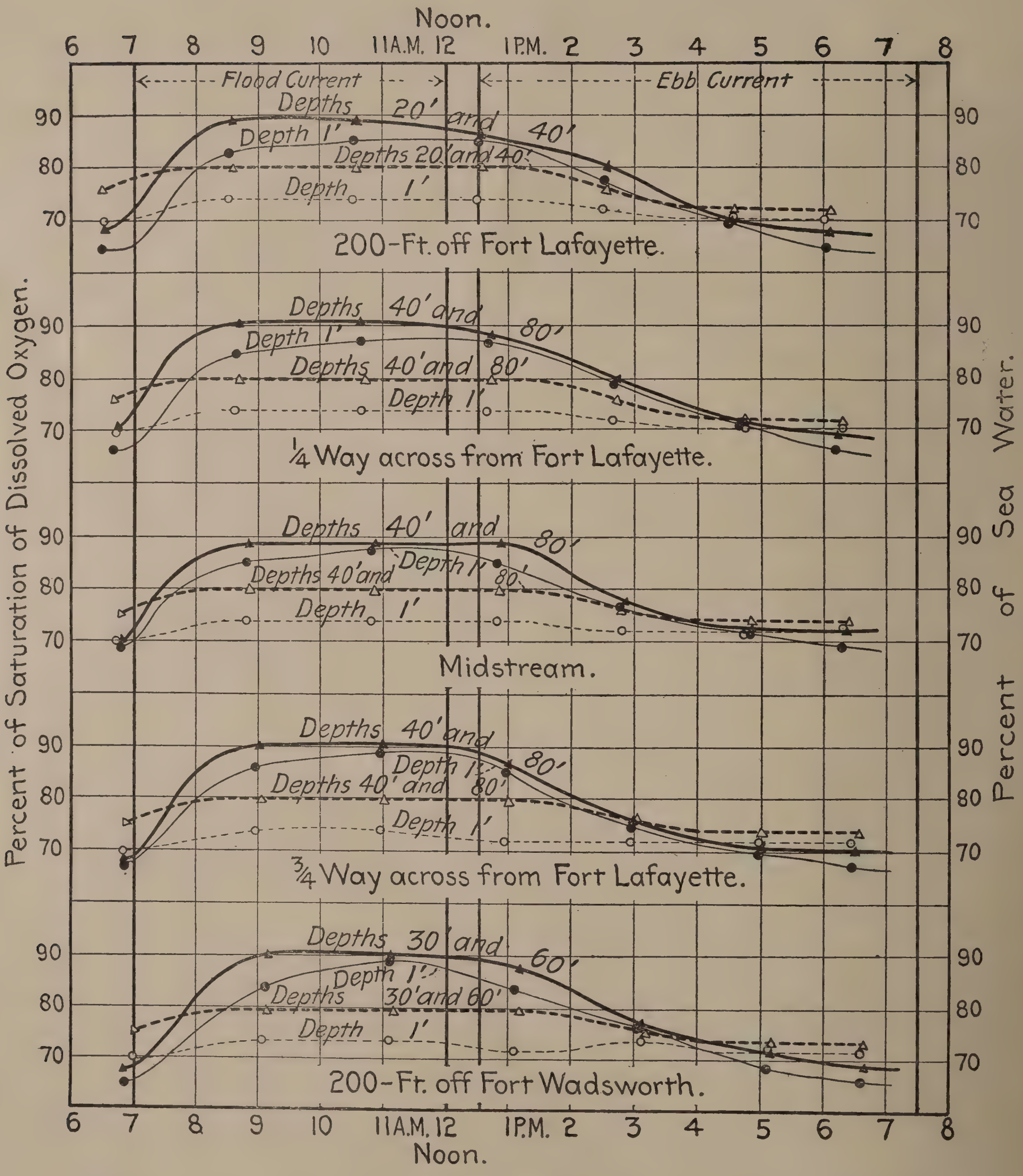
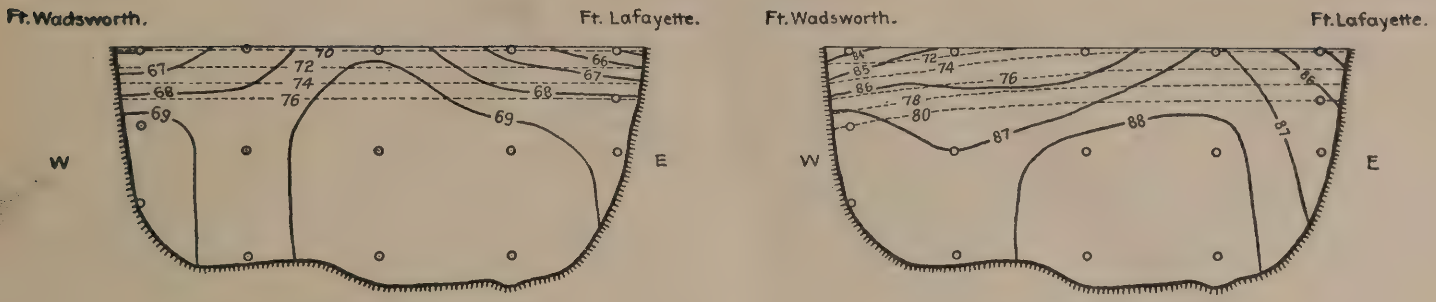


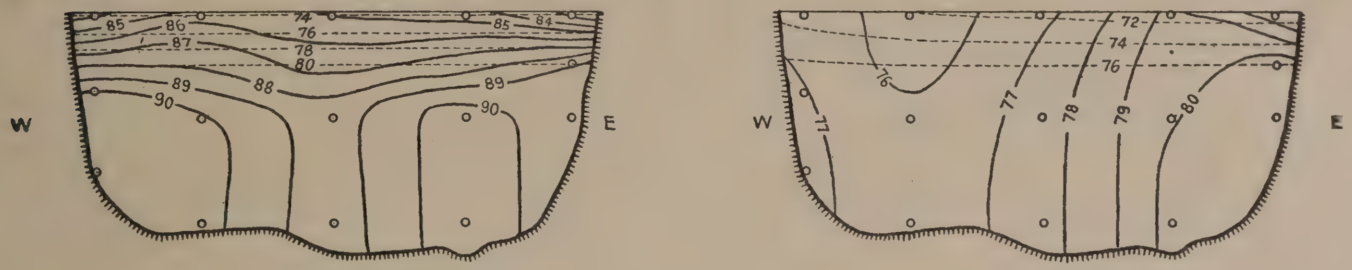
FIG. 138

Percentage of Saturation of Dissolved Oxygen in Full Lines, and Percentage of Sea Water in Broken Lines in a Cross Section of the Narrows from Fort Wadsworth to Fort Lafayette, at Various Stages of Tide, September 26, 1911. The Total Number of Samples included is 105. The Results of Analysis are indicated by Small Circles and Triangles



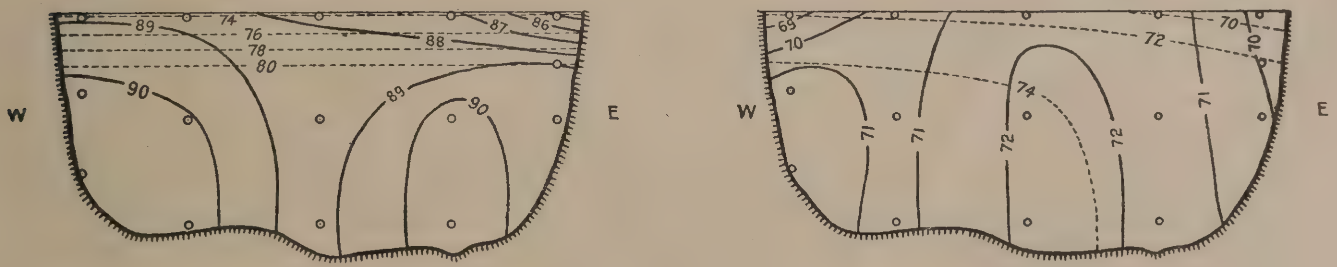
6:30 – 7:10 A.M
(15 Samples, Nos. 1474 – 1488.)
Slack Water at End of Ebb Current.

12:30 – 1:10 P.M.
(15 Samples, Nos. 1519 – 1533.)
1 Hour after Beginning of Ebb Current.



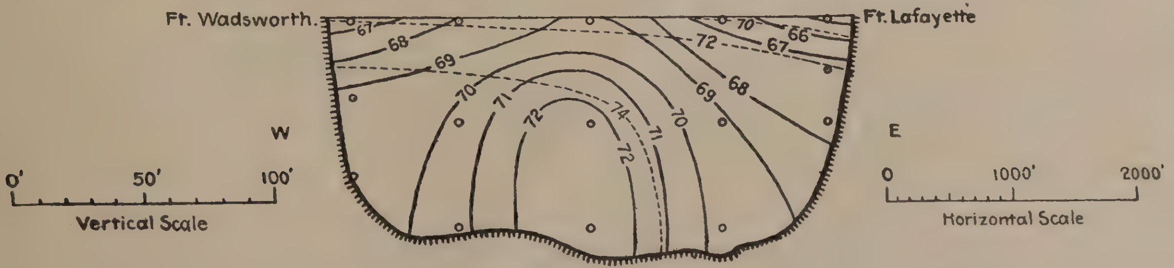
8:30 – 9:30 A.M.
(15 Samples, Nos. 1489 – 1503.)
2 Hours after Beginning of Flood Current.

2:30 – 3:10 P.M.
(15 Samples, Nos. 1534 – 1548.)
3 Hours after Beginning of Ebb Current.



10:30 – 11:10 A.M.
(15 Samples, Nos. 1504 – 1518.)
1 Hour before End of Flood Current.

4:30 – 5:10 P.M.
(15 Samples, Nos. 1549 – 1563.)
5 Hours after Beginning off Ebb Current.



6:0 – 6:30 P.M.
(15 Samples, Nos. 1564 – 1578.)
1 Hour before End off Ebb Current.

FIG. 139

Cross Section of the Narrows from Fort Wadsworth to Fort Lafayette, Showing Percentage of Saturation of Dissolved Oxygen in Full Lines and Percentage of Sea Water in Broken Lines, at Various Stages of Tide, September 26, 1911. The Total Number of Samples included is 105. Sampling Points are indicated by Small Circles

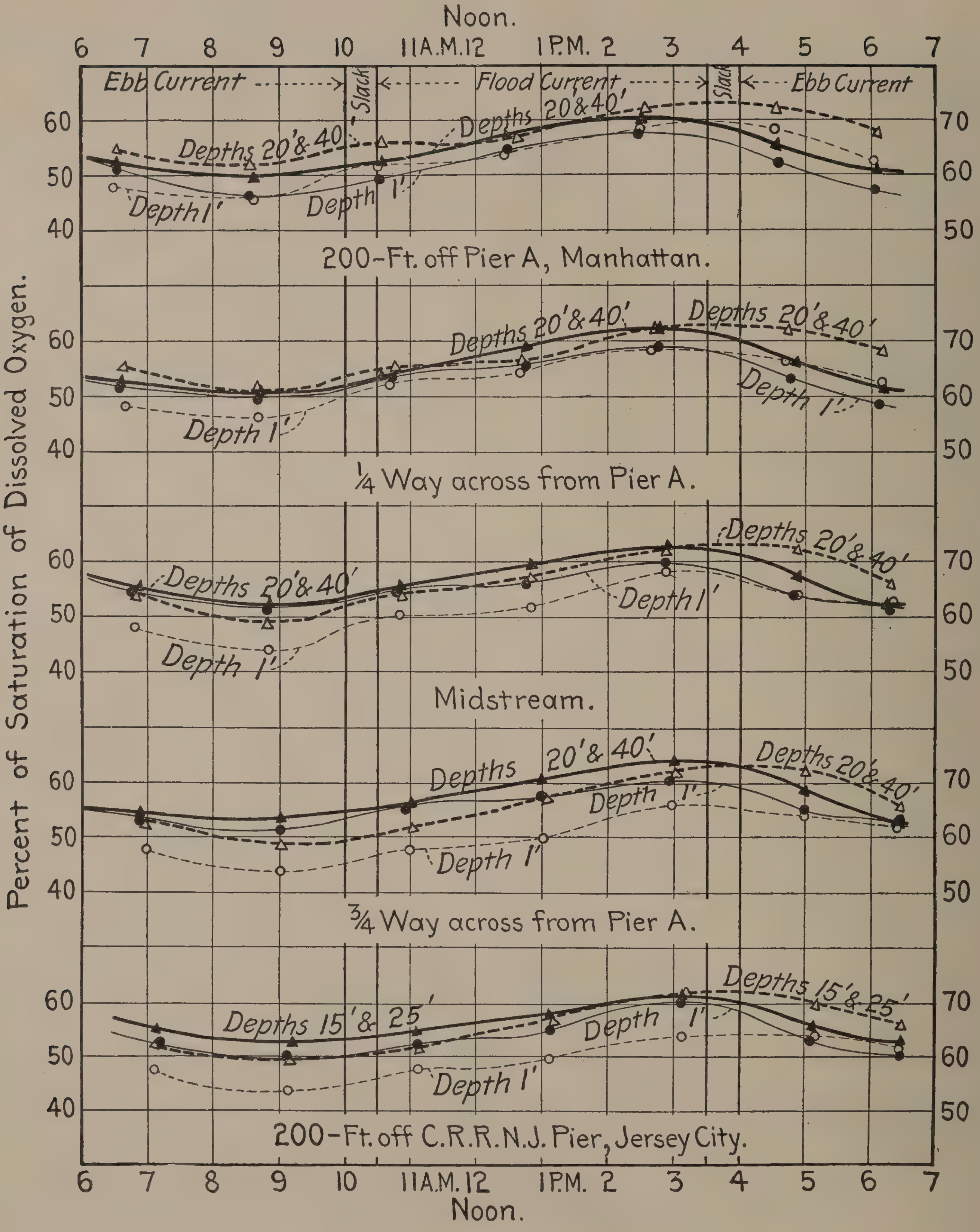
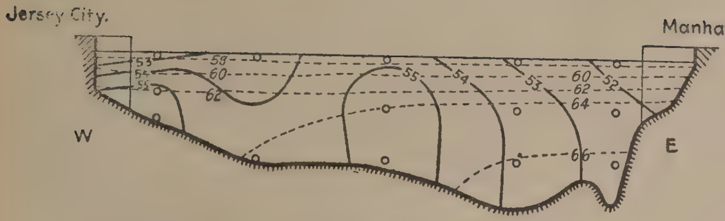
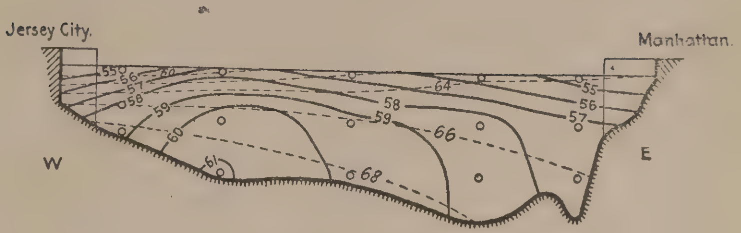


FIG. 140

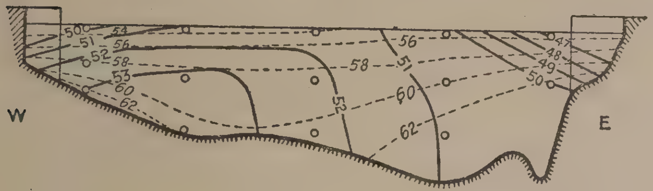
Percentage of Saturation of Dissolved Oxygen in Full Lines and Percentage of Sea Water in Broken Lines in a Cross Section of the Mouth of the Hudson River from Pier A, Manhattan, to C. R.R. of N. J. Terminal, Jersey City, at Various Stages of Tide, September 28, 1911. The Total Number of Samples included is 105. The Results of Analysis are indicated by Small Circles and Triangles



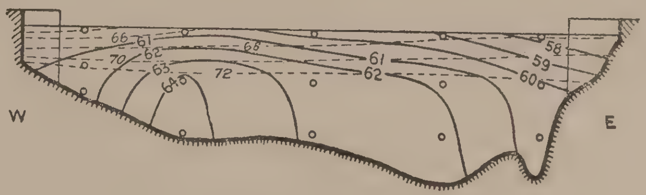
6:30–7:10 A.M.
(15 Samples, Nos. 1579–1593.)
3½ Hours After Beginning of Ebb Current.



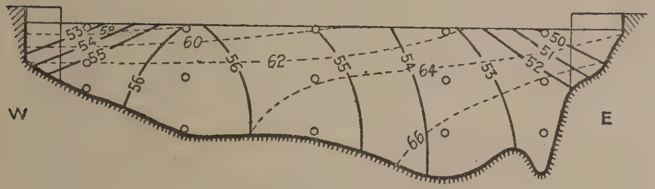
12:30 – 1:10 A.M.
(15 Samples, Nos. 1624–1638.)
2½ Hours After Beginning of Flood Current.



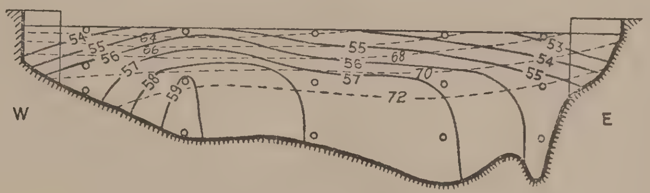
8:30 – 9:10 A.M.
(15 Samples, Nos. 1594–1608.)
5½ Hours After Beginning of Ebb Current.



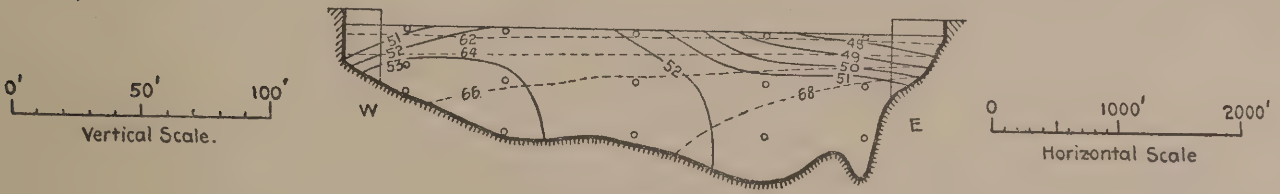
2.30 – 3:10 P.M
(15 Samples, Nos 1639 – 1653)
4½ Hours After Beginning of Flood Current.



10:30 – 11:10 A.M.
(15 Samples, Nos. 1609 – 1623.)
½ Hour After Beginning of Flood Current.



4.30 – 5.10 P.M.
(15 Samples, Nos. 1654 – 1668.)
1 Hour After Beginning of Ebb Current.



6:00 – 6:30 P.M.
(15 Samples, Nos. 1669 – 1683.)
2½ Hours After Beginning of Ebb Current.

FIG. 141

Cross Section of the Mouth of the Hudson River from Pier A, Manhattan, to C. R.R. of N. J. Terminal, Jersey City, Showing Percentage of Saturation of Dissolved Oxygen in Full Lines and Percentage of Sea Water in Broken Lines, at Various Stages of Tide, September 28, 1911. The Total Number of Samples included is 105. Sampling Points are indicated by Small Circles

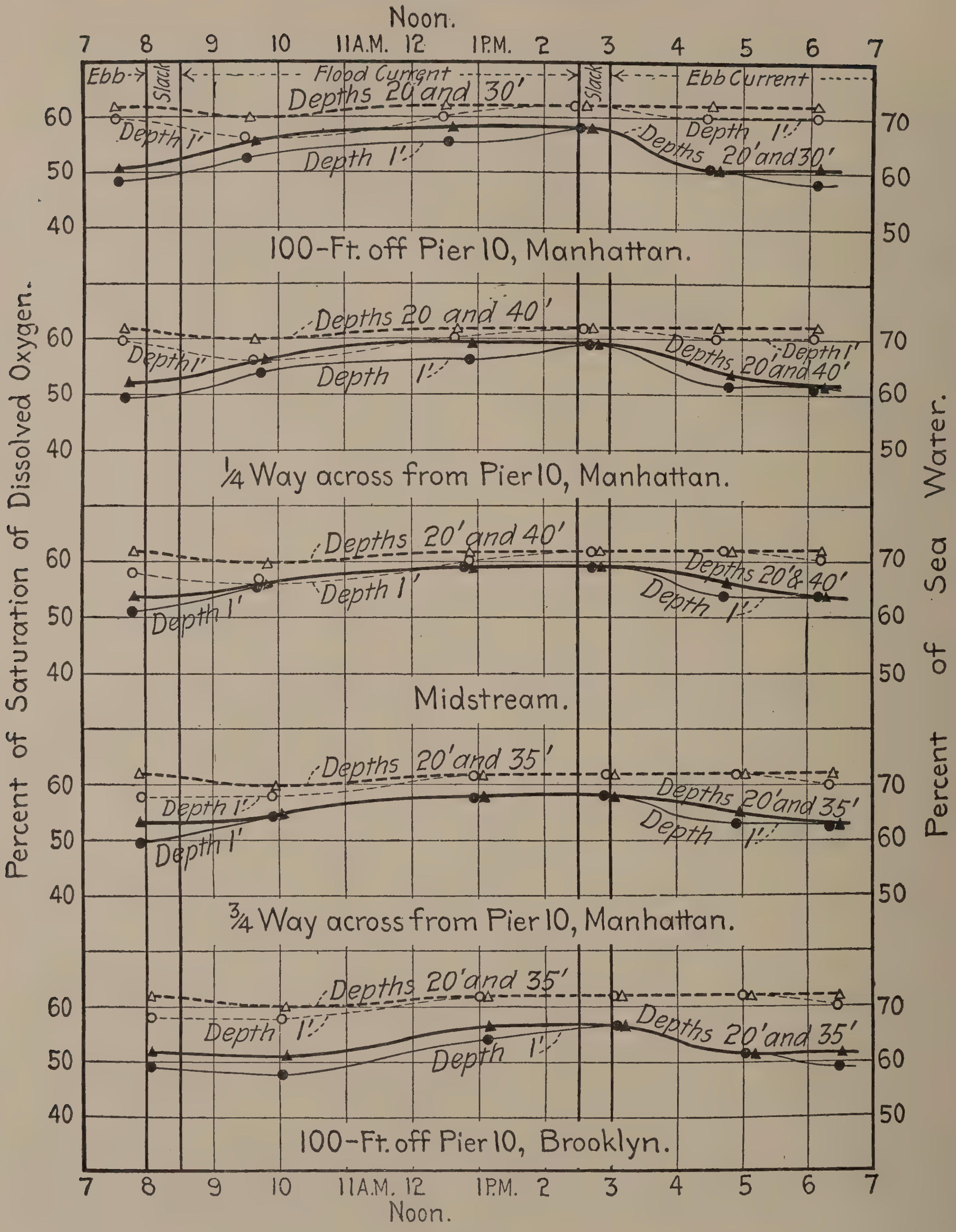
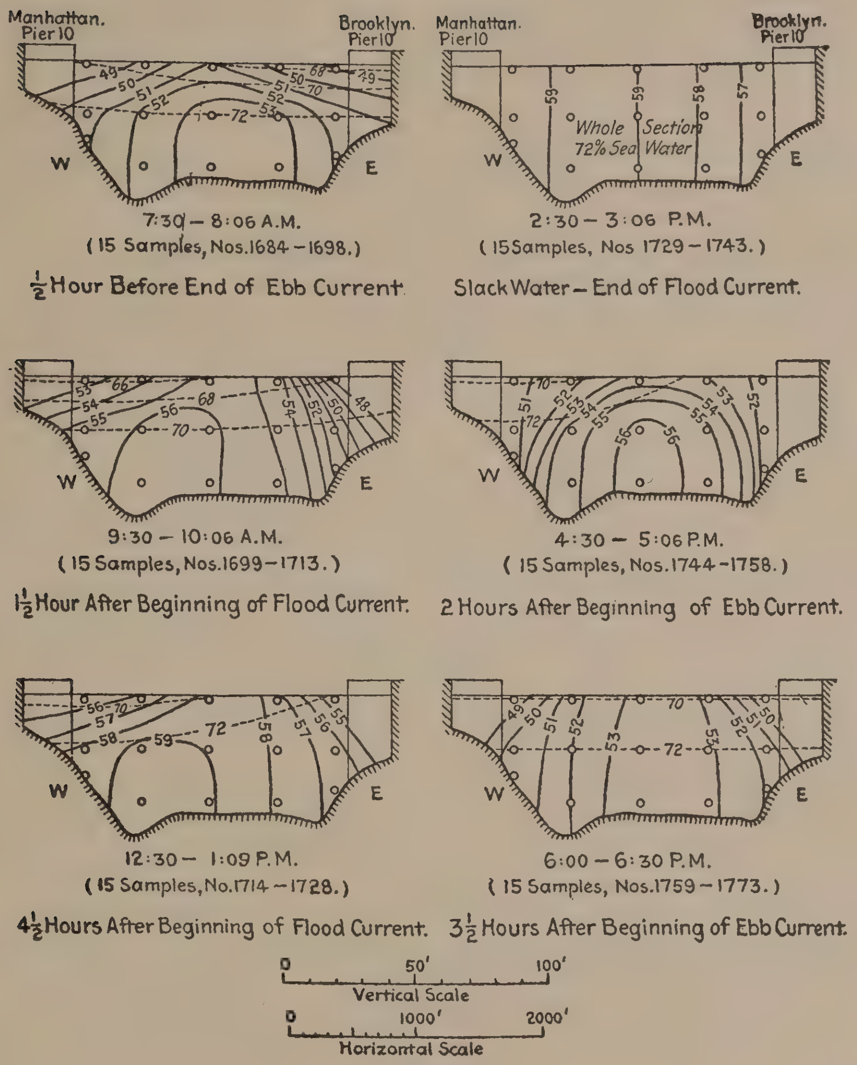


FIG. 142

Percentage of Saturation of Dissolved Oxygen in Full Lines, and Percentage of Sea Water in Broken Lines in a Cross Section of the Mouth of the East River from Pier 10, Manhattan, to Pier 10, Brooklyn, at Various Stages of Tide, September 29, 1911. The Total Number of Samples included is 90. The Results of Analysis are indicated by Small Circles and Triangles



7:30 – 8:06 A.M.
(15 Samples, Nos. 1684 – 1698.)
½ Hour Before End of Ebb Current.

2:30 – 3:06 P.M.
(15 Samples, Nos 1729 – 1743.)
Slack Water – End of Flood Current.

9:30 – 10:06 A.M.
(15 Samples, Nos. 1699 – 1713.)
1½ Hour After Beginning of Flood Current.

4:30 – 5:06 P.M.
(15 Samples, Nos. 1744 – 1758.)
2 Hours After Beginning of Ebb Current.

12:30 – 1:09 P.M.
(15 Samples, No. 1714 – 1728.)
4½ Hours After Beginning of Flood Current.

6:00 – 6:30 P.M.
(15 Samples, Nos. 1759 – 1773.)
3½ Hours After Beginning of Ebb Current.

FIG. 143

Cross Section of the Mouth of the East River from Pier 10, Manhattan, to Pier 10, Brooklyn, Showing Percentage of Saturation of Dissolved Oxygen in Full Lines and Percentage of Sea Water in Broken Lines, at Various Stages of Tide, September 29, 1911. The Total Number of Samples included is 90. Sampling Points are indicated by Small Circles

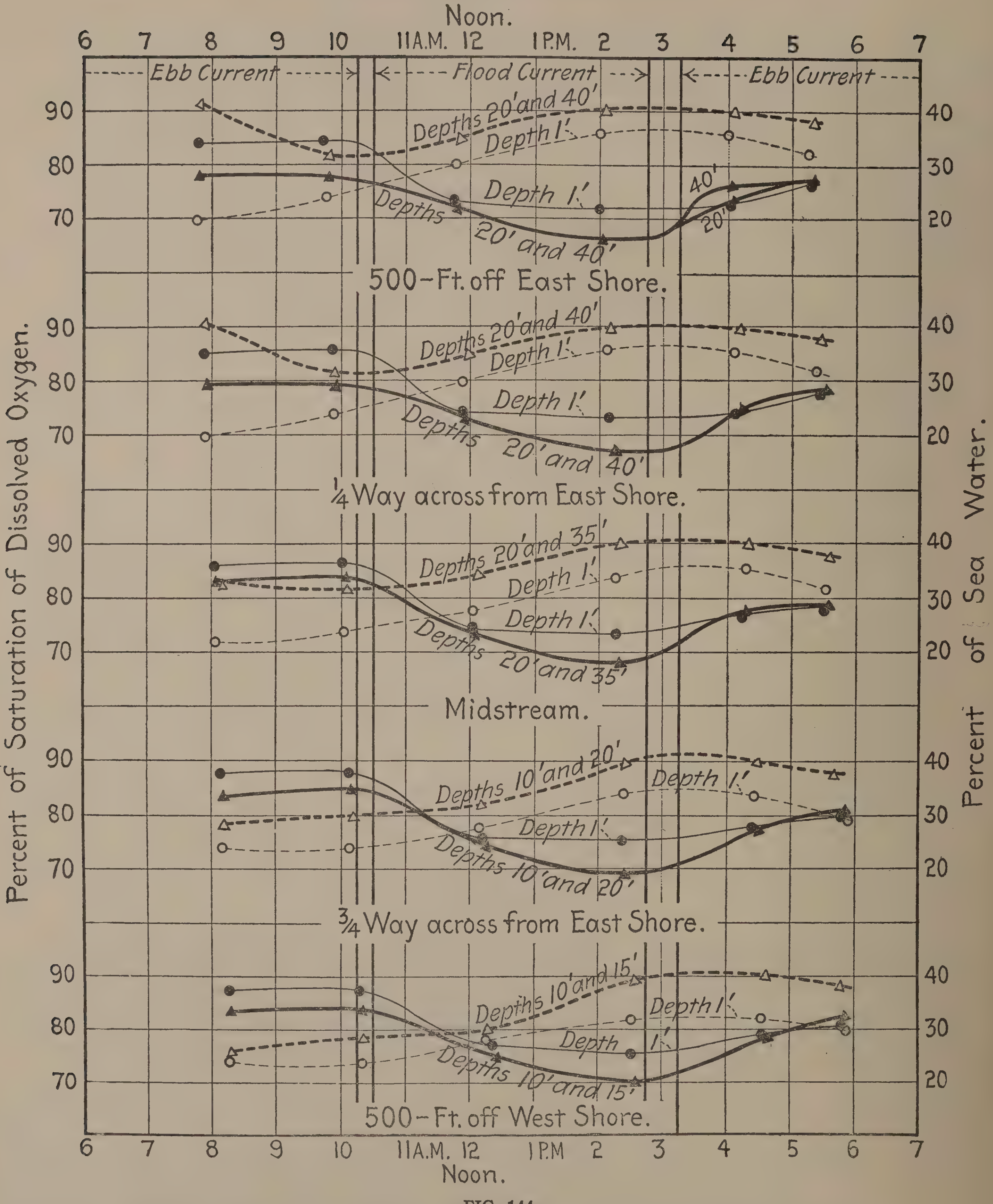
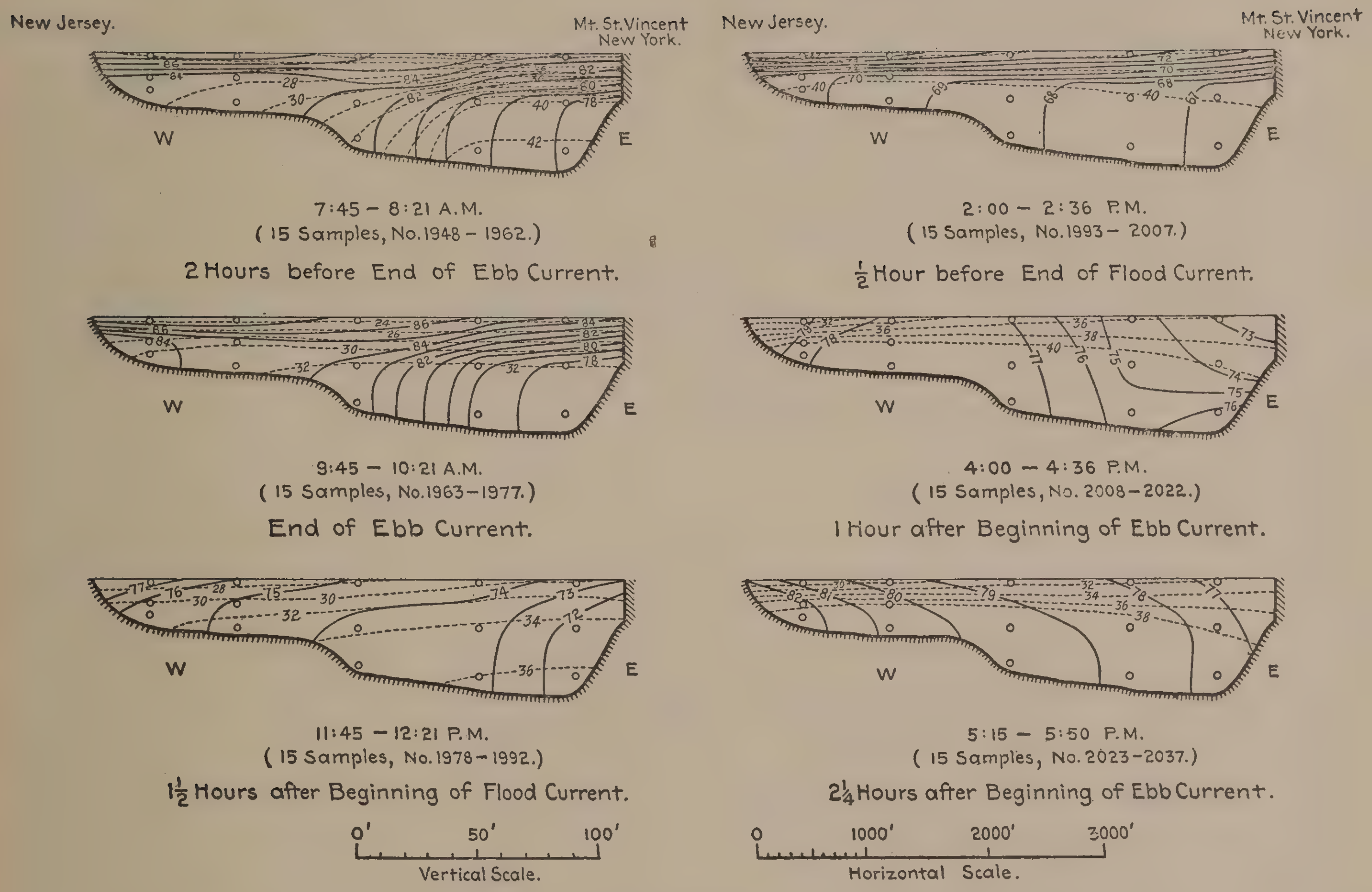


FIG. 144

Percentage of Saturation of Dissolved Oxygen in Full Lines, and Percentage of Sea Water in Broken Lines in a Cross Section of the Hudson River at Mt. St. Vincent, at Various Stages of Tide, October 13, 1911. The Total Number of Samples included is 90. The Results of Analysis are indicated by Small Circles and Triangles



7:45 – 8:21 A.M.
(15 Samples, No. 1948 – 1962.)
2 Hours before End of Ebb Current.

2:00 – 2:36 P.M.
(15 Samples, No. 1993 – 2007.)
½ Hour before End of Flood Current.

9:45 – 10:21 A.M.
(15 Samples, No. 1963 – 1977.)
End of Ebb Current.

4:00 – 4:36 P.M.
(15 Samples, No. 2008 – 2022.)
1 Hour after Beginning of Ebb Current.

11:45 – 12:21 P.M.
(15 Samples, No. 1978 – 1992.)
1½ Hours after Beginning of Flood Current.

5:15 – 5:50 P.M.
(15 Samples, No. 2023 – 2037.)
2¼ Hours after Beginning of Ebb Current.

FIG. 145

Cross Section of the Hudson River at Mt. St. Vincent, Showing Percentage of Saturation of Dissolved Oxygen in Full Lines, and Percentage of Sea Water in Broken Lines, at Various Stages of Tide, October 13, 1911. The Total Number of Samples included is 90. Sampling Points are indicated by Small Circles

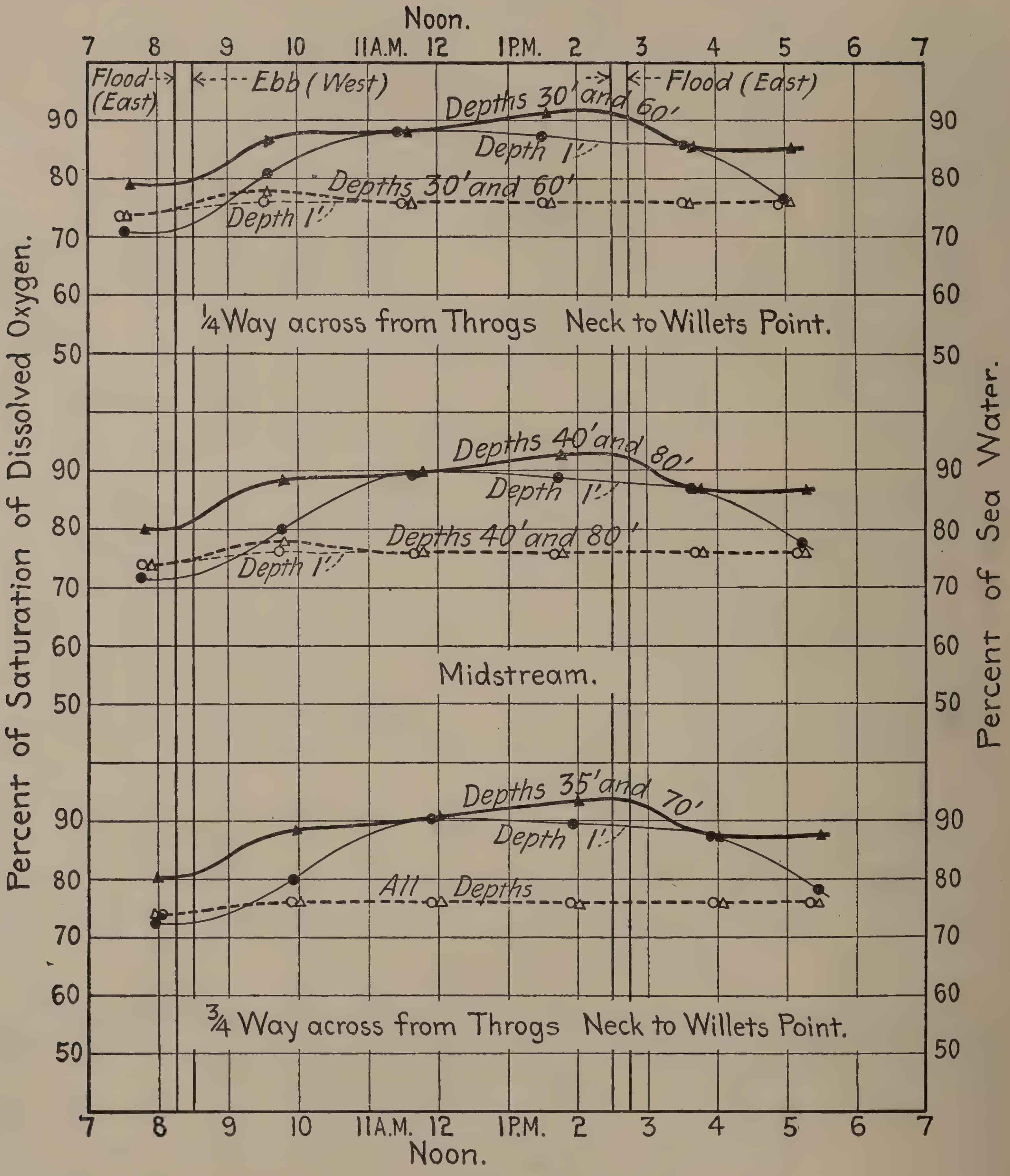
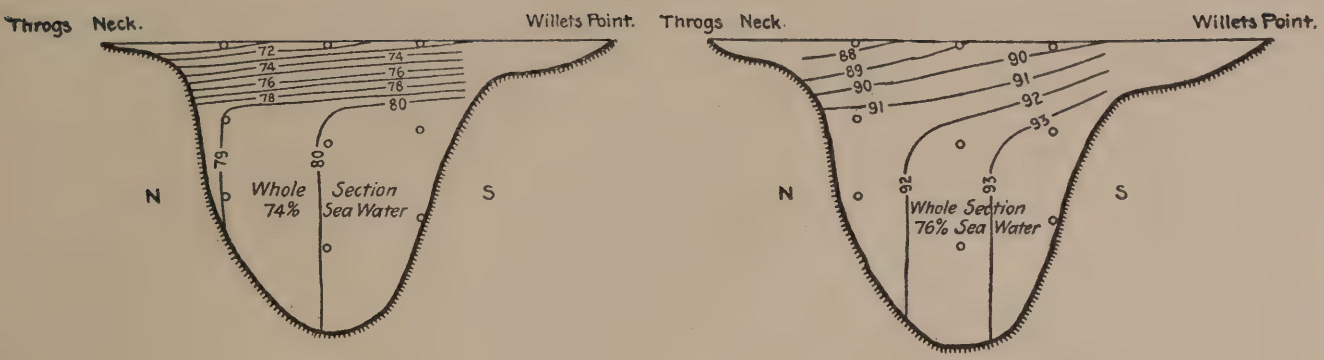


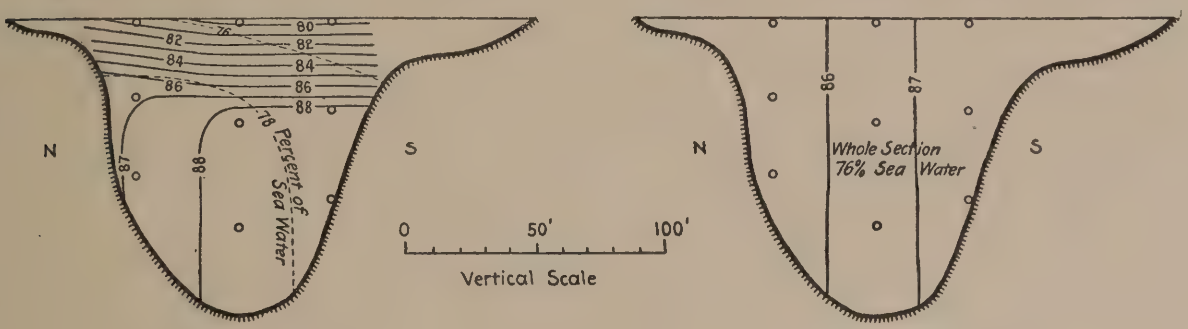
FIG. 146

Percentage of Saturation of Dissolved Oxygen in Full Lines, and Percentage of Sea Water in Broken Lines, in a Cross Section of the East River from Throgs Neck to Willets Point, at Various Stages of Tide, October 25, 1911. The Total Number of Samples included is 54. The Results of Analysis are indicated by Small Circles and Triangles



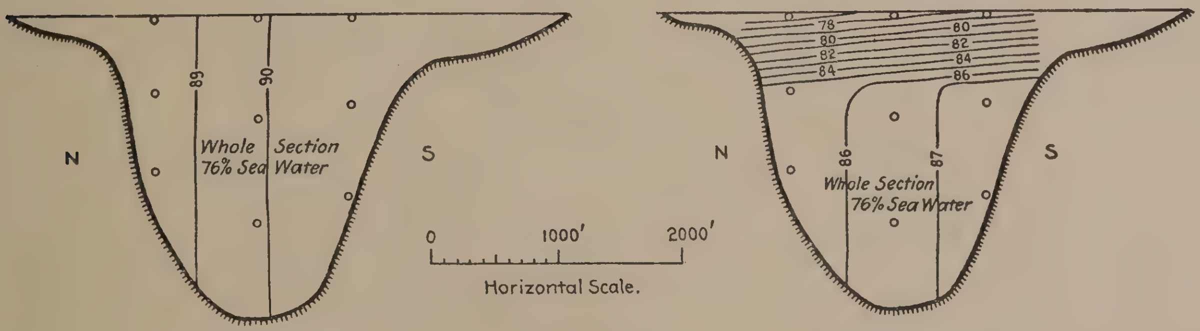
7:30 – 8:00 A. M.
(9 Samples, Nos. 2173 – 2181.)
½ Hour Before End of Flood Current (East.)

1:30 – 2:00 P. M.
(9 Samples, Nos. 2200 – 2208.)
5 Hours After Beginning of Ebb Current (West.)



9:30 – 10:00 A. M.
(9 Samples, Nos. 2182 – 2190.)
1 Hour After Beginning of Ebb Current (West.)

3:30 – 4:00 P. M.
(9 Samples, Nos. 2209 – 2217.)
1 Hour After Beginning of Flood Current (East.)



11:30 – 12:00 M.
(9 Samples, Nos. 2191 – 2199.)
3 Hours After Beginning of Ebb Current (West.)

5:00 – 5:30 P. M.
(9 Samples, Nos. 2218 – 2226.)
2½ Hours After Beginning of Flood Current (East.)

FIG. 147

Cross Section of the East River from Throgs Neck to Willets Point, Showing Percentage of Saturation of Dissolved Oxygen in Full Lines, and Percentage of Sea Water in Broken Lines, at Various Stages of Tide, October 25, 1911. The Total Number of Samples included is 54. Sampling Points are indicated by Small Circles

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